FIG.1

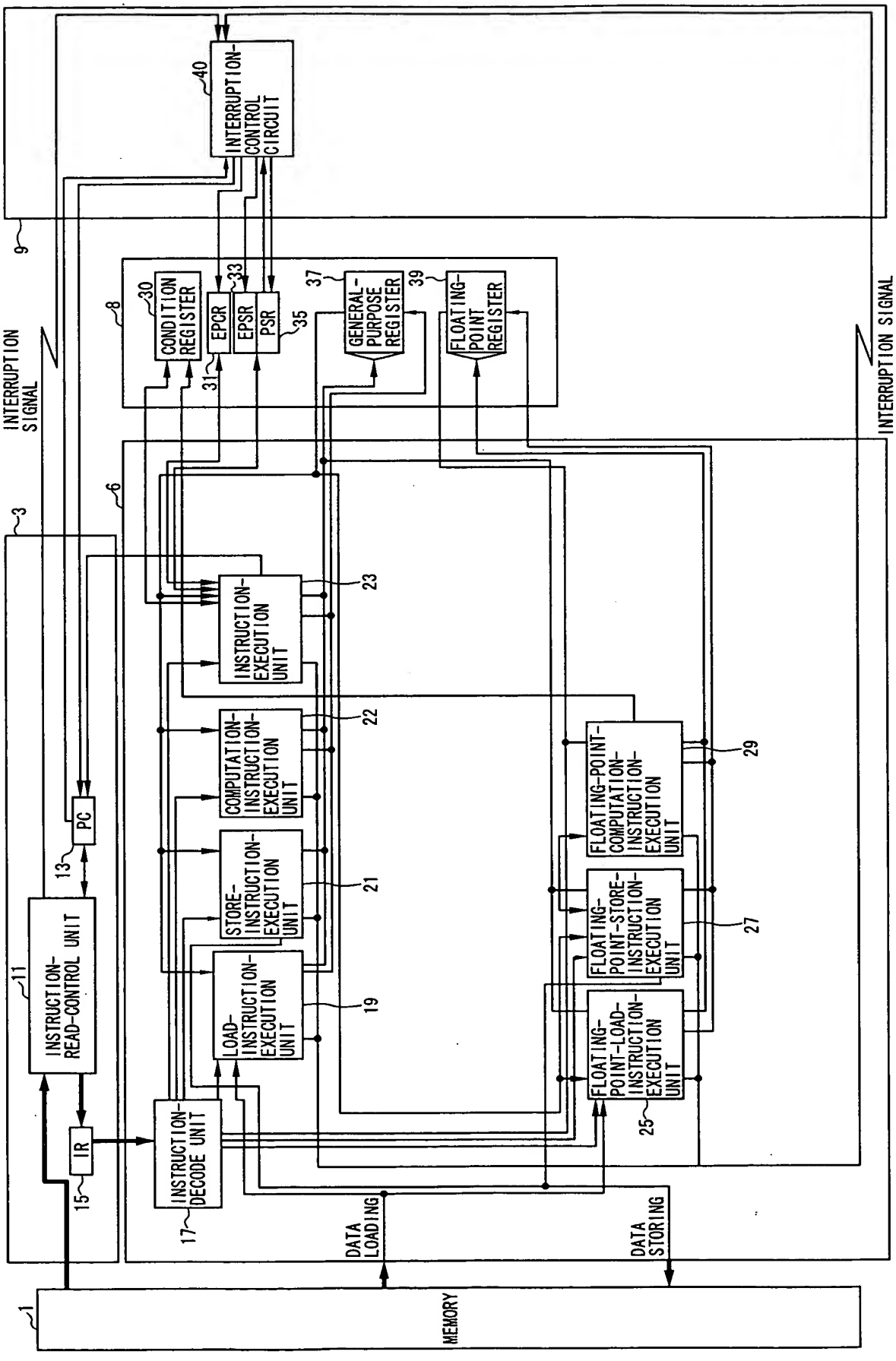

MEMORY
1
DATA LOADING
DATA STORING
INSTRUCTION-DECODE UNIT
17
IR
15
INSTRUCTION-READ-CONTROL UNIT
11
PC
13
LOAD-INSTRUCTION-EXECUTION UNIT
19
STORE-INSTRUCTION-EXECUTION UNIT
21
COMPUTATION-INSTRUCTION-EXECUTION UNIT
22
INSTRUCTION-EXECUTION UNIT
23
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
25
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
27
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
29
3
6
8
9
INTERRUPTION SIGNAL
INTERRUPTION SIGNAL
CONDITION REGISTER
30
EPCR
31
EPSR
33
PSR
35
GENERAL-PURPOSE REGISTER
37
FLOATING-POINT REGISTER
39
INTERRUPTION-CONTROL CIRCUIT
40

FIG.2

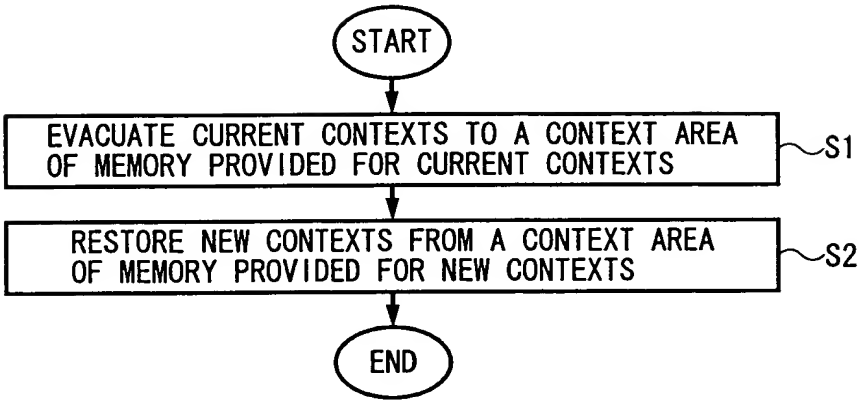

START
EVACUATE CURRENT CONTEXTS TO A CONTEXT AREA OF MEMORY PROVIDED FOR CURRENT CONTEXTS
S1
RESTORE NEW CONTEXTS FROM A CONTEXT AREA OF MEMORY PROVIDED FOR NEW CONTEXTS
S2
END

FIG.3

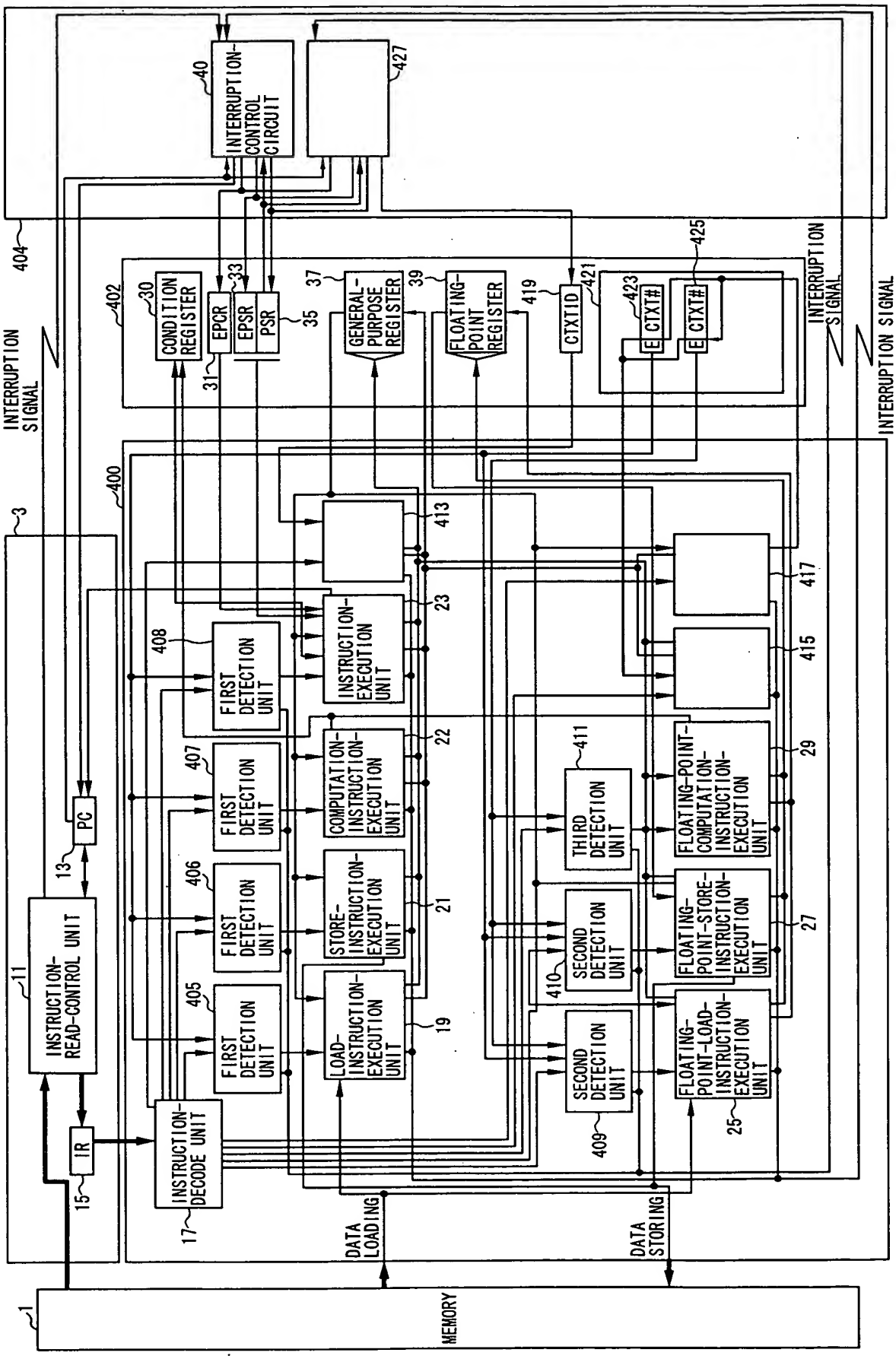

MEMORY
DATA LOADING
DATA STORING
INSTRUCTION-READ-CONTROL UNIT
INSTRUCTION-DECODE UNIT
PC
IR
FIRST DETECTION UNIT
SECOND DETECTION UNIT
THIRD DETECTION UNIT
LOAD-INSTRUCTION-EXECUTION UNIT
STORE-INSTRUCTION-EXECUTION UNIT
COMPUTATION-INSTRUCTION-EXECUTION UNIT
INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
INTERRUPTION-CONTROL CIRCUIT
CONDITION REGISTER
EPCR
EPSR
PSR
GENERAL-PURPOSE REGISTER
FLOATING-POINT REGISTER
CTXTID
CTXT#
INTERRUPTION SIGNAL

FIG.4

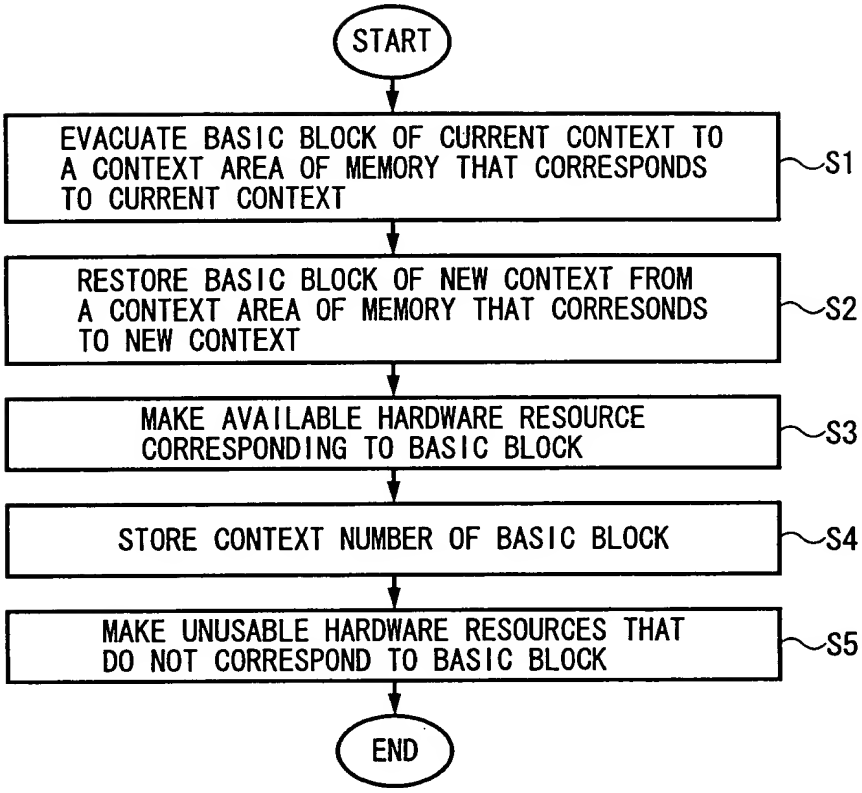

START
EVACUATE BASIC BLOCK OF CURRENT CONTEXT TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT
S1
RESTORE BASIC BLOCK OF NEW CONTEXT FROM A CONTEXT AREA OF MEMORY THAT CORRESONDS TO NEW CONTEXT
S2
MAKE AVAILABLE HARDWARE RESOURCE CORRESPONDING TO BASIC BLOCK
S3
STORE CONTEXT NUMBER OF BASIC BLOCK
S4
MAKE UNUSABLE HARDWARE RESOURCES THAT DO NOT CORRESPOND TO BASIC BLOCK
S5
END

FIG.5

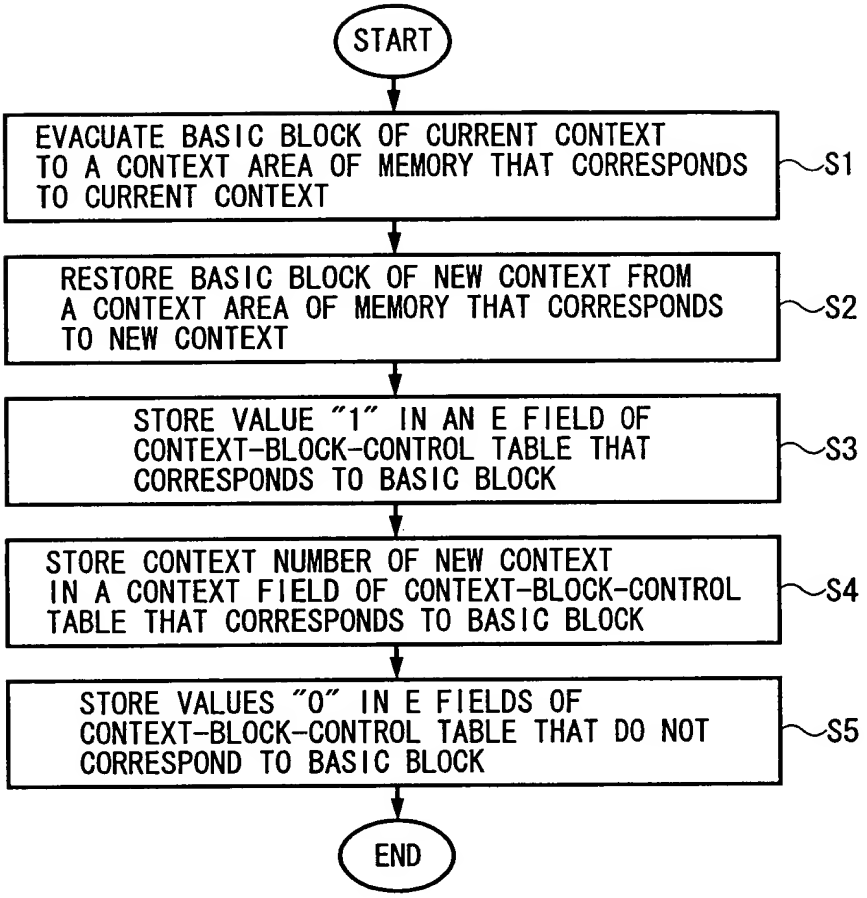

START
EVACUATE BASIC BLOCK OF CURRENT CONTEXT TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT
S1
RESTORE BASIC BLOCK OF NEW CONTEXT FROM A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO NEW CONTEXT
S2
STORE VALUE "1" IN AN E FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO BASIC BLOCK
S3
STORE CONTEXT NUMBER OF NEW CONTEXT IN A CONTEXT FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO BASIC BLOCK
S4
STORE VALUES "0" IN E FIELDS OF CONTEXT-BLOCK-CONTROL TABLE THAT DO NOT CORRESPOND TO BASIC BLOCK
S5
END

FIG.6

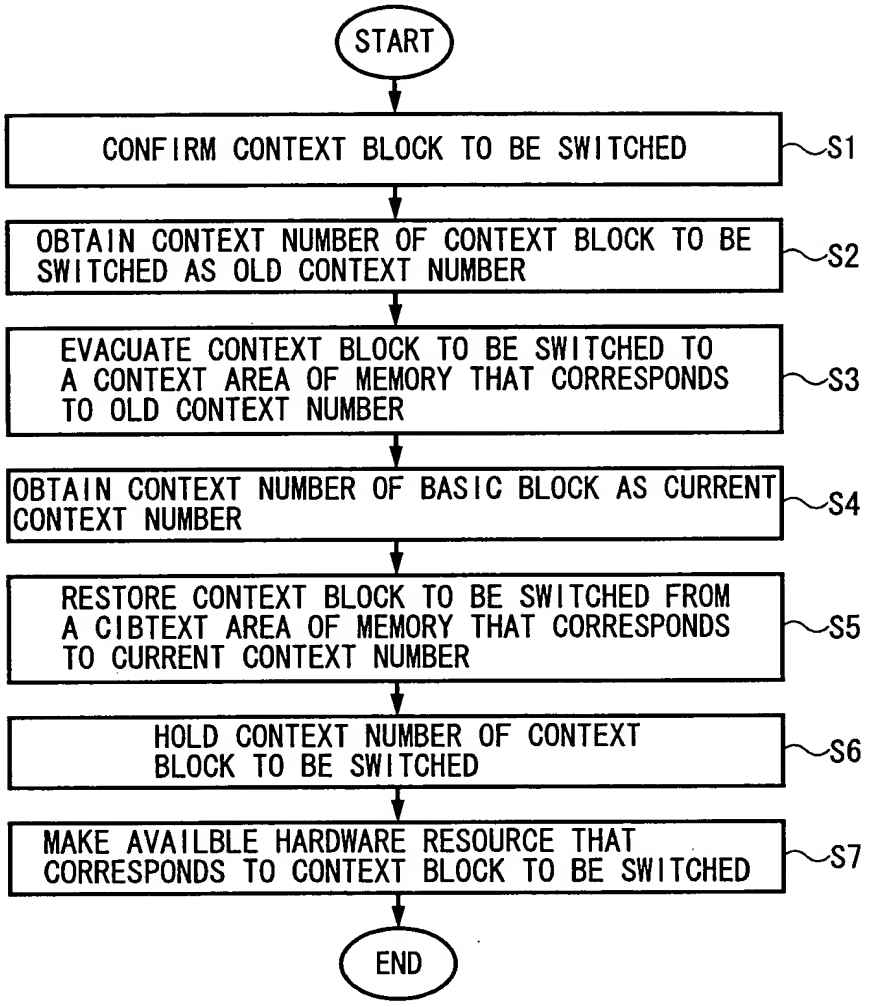

START
CONFIRM CONTEXT BLOCK TO BE SWITCHED
S1
OBTAIN CONTEXT NUMBER OF CONTEXT BLOCK TO BE SWITCHED AS OLD CONTEXT NUMBER
S2
EVACUATE CONTEXT BLOCK TO BE SWITCHED TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO OLD CONTEXT NUMBER
S3
OBTAIN CONTEXT NUMBER OF BASIC BLOCK AS CURRENT CONTEXT NUMBER
S4
RESTORE CONTEXT BLOCK TO BE SWITCHED FROM A CIBTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT NUMBER
S5
HOLD CONTEXT NUMBER OF CONTEXT BLOCK TO BE SWITCHED
S6
MAKE AVAILBLE HARDWARE RESOURCE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S7
END

FIG.7

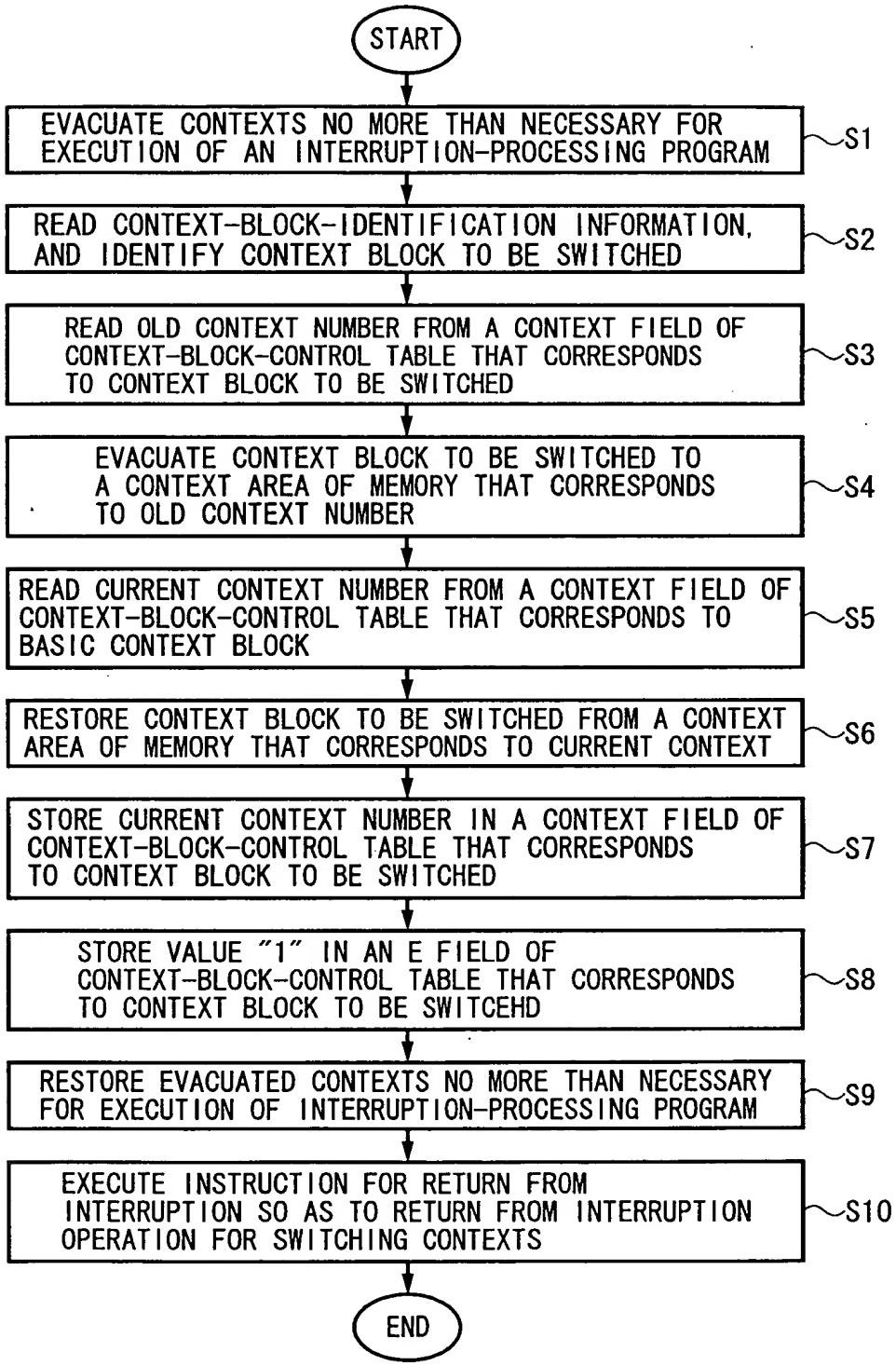

START
EVACUATE CONTEXTS NO MORE THAN NECESSARY FOR EXECUTION OF AN INTERRUPTION-PROCESSING PROGRAM
S1
READ CONTEXT-BLOCK-IDENTIFICATION INFORMATION, AND IDENTIFY CONTEXT BLOCK TO BE SWITCHED
S2
READ OLD CONTEXT NUMBER FROM A CONTEXT FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S3
EVACUATE CONTEXT BLOCK TO BE SWITCHED TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO OLD CONTEXT NUMBER
S4
READ CURRENT CONTEXT NUMBER FROM A CONTEXT FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO BASIC CONTEXT BLOCK
S5
RESTORE CONTEXT BLOCK TO BE SWITCHED FROM A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT
S6
STORE CURRENT CONTEXT NUMBER IN A CONTEXT FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S7
STORE VALUE "1" IN AN E FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCEHD
S8
RESTORE EVACUATED CONTEXTS NO MORE THAN NECESSARY FOR EXECUTION OF INTERRUPTION-PROCESSING PROGRAM
S9
EXECUTE INSTRUCTION FOR RETURN FROM INTERRUPTION SO AS TO RETURN FROM INTERRUPTION OPERATION FOR SWITCHING CONTEXTS
S10
END

FIG.8

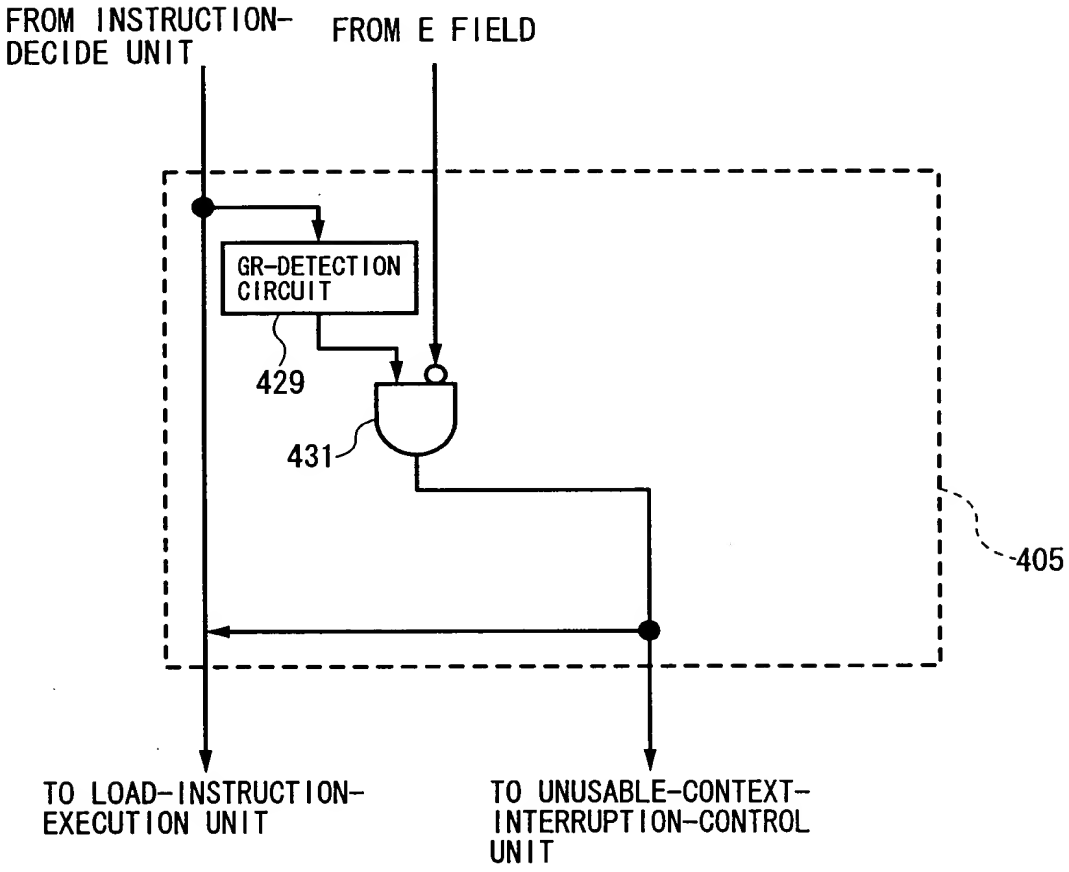

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
GR-DETECTION CIRCUIT
429
431
405
TO LOAD-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.9

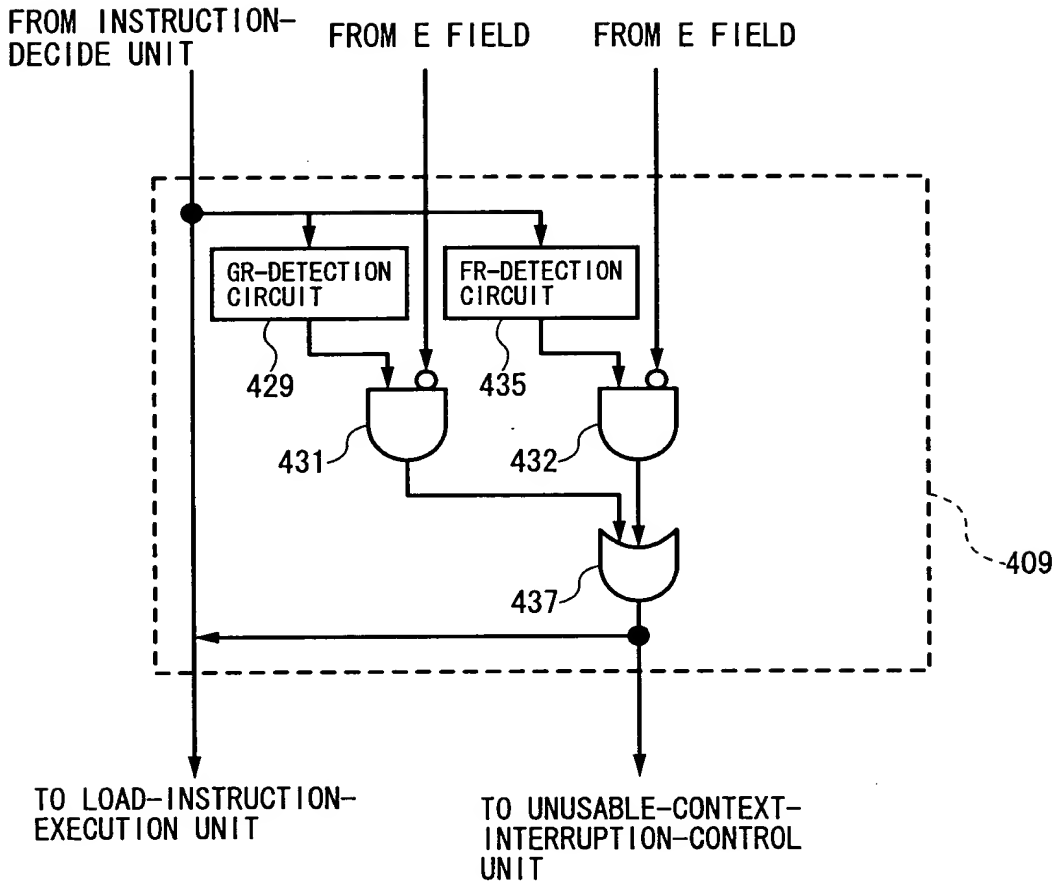

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FROM E FIELD
GR-DETECTION CIRCUIT
FR-DETECTION CIRCUIT
429
435
431
432
437
409
TO LOAD-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.10

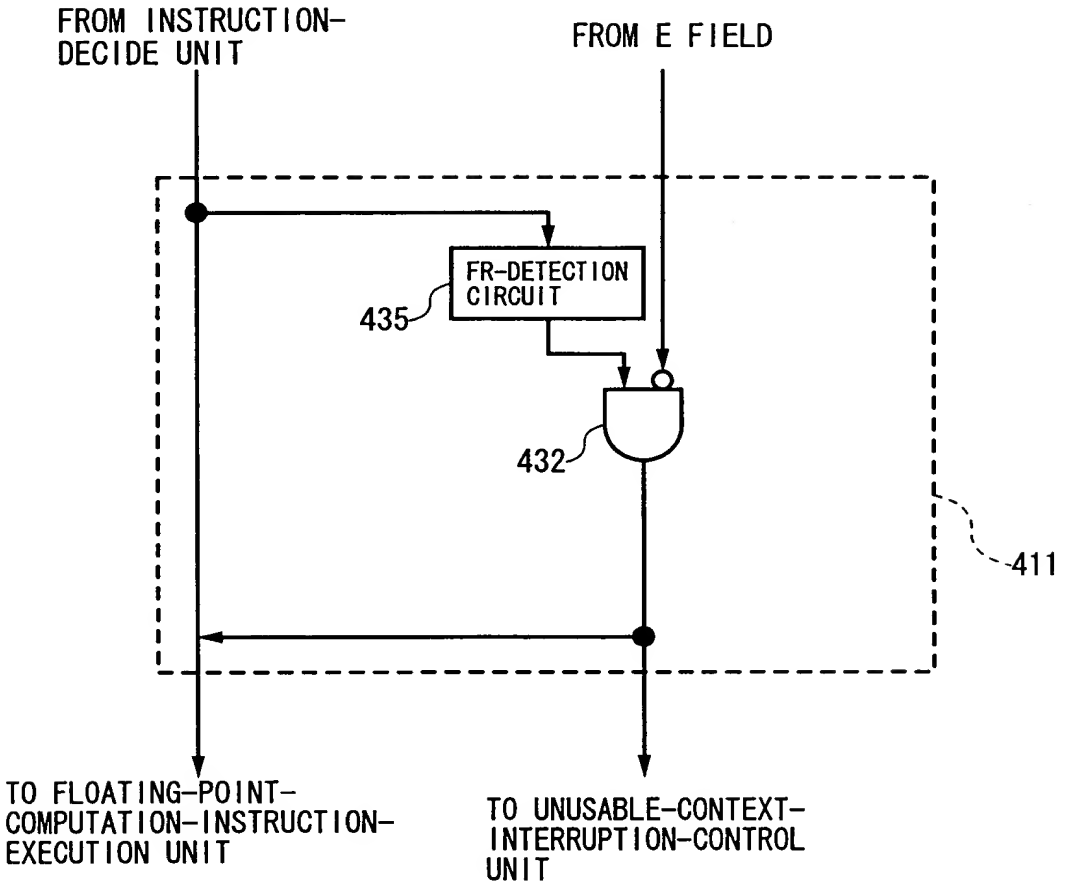

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FR-DETECTION CIRCUIT
435
432
411
TO FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.11

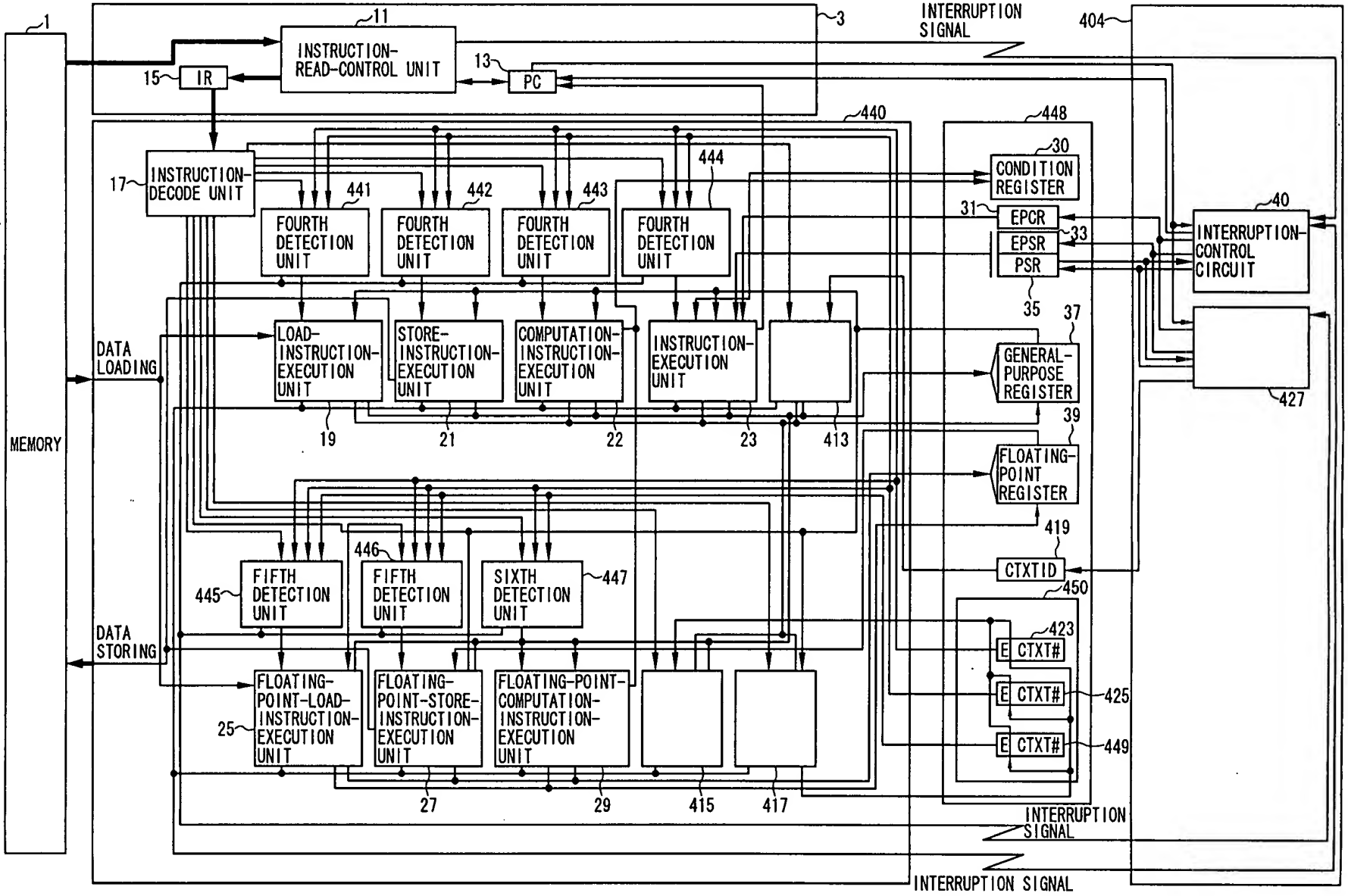

1
MEMORY
3
11
INSTRUCTION-READ-CONTROL UNIT
13
PC
15
IR
17
INSTRUCTION-DECODE UNIT
INTERRUPTION SIGNAL
404
440
441
442
443
444
FOURTH DETECTION UNIT
FOURTH DETECTION UNIT
FOURTH DETECTION UNIT
FOURTH DETECTION UNIT
DATA LOADING
LOAD-INSTRUCTION-EXECUTION UNIT
STORE-INSTRUCTION-EXECUTION UNIT
COMPUTATION-INSTRUCTION-EXECUTION UNIT
INSTRUCTION-EXECUTION UNIT
19
21
22
23
413
DATA STORING
445
446
447
FIFTH DETECTION UNIT
FIFTH DETECTION UNIT
SIXTH DETECTION UNIT
25
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
27
29
415
417
448
30
CONDITION REGISTER
31
EPCR
33
EPSR
PSR
35
37
GENERAL-PURPOSE REGISTER
39
FLOATING-POINT REGISTER
419
CTXTID
450
423
E CTXT#
E CTXT#
E CTXT#
425
449
40
INTERRUPTION-CONTROL CIRCUIT
427
INTERRUPTION SIGNAL
INTERRUPTION SIGNAL

FIG.12

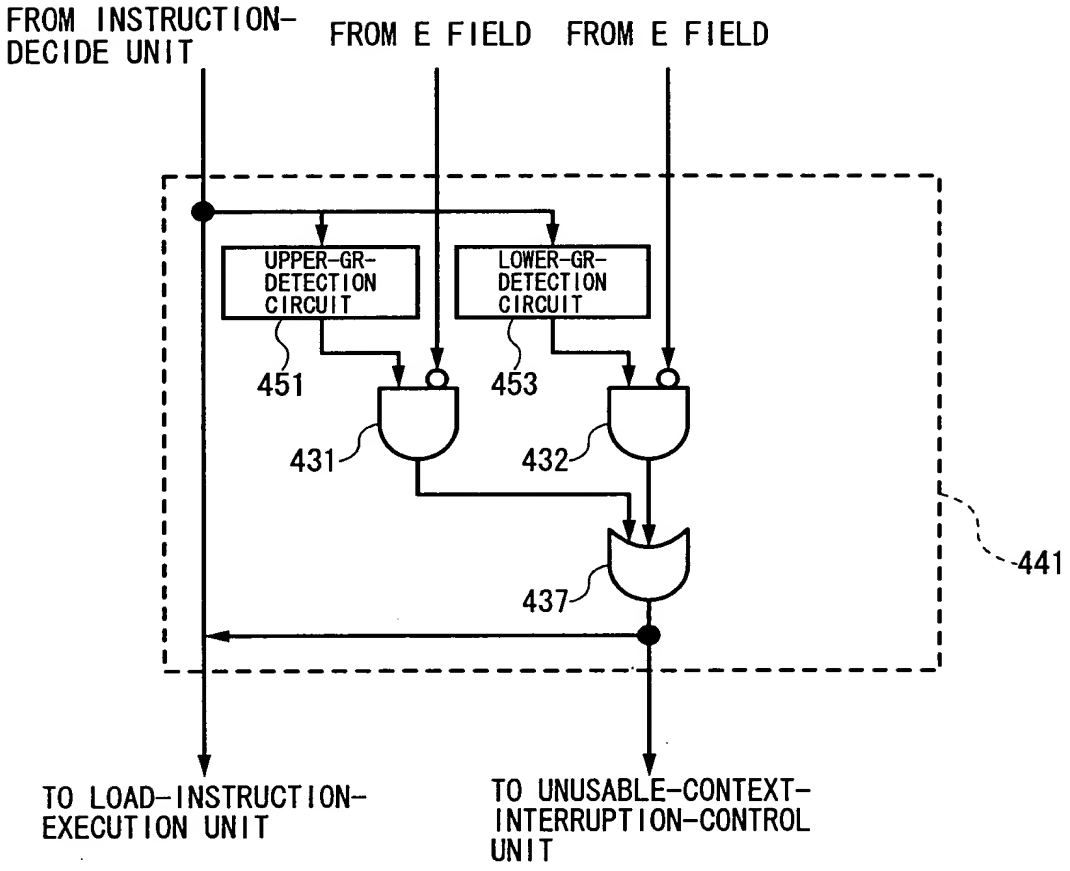

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FROM E FIELD
UPPER-GR-DETECTION CIRCUIT
LOWER-GR-DETECTION CIRCUIT
451
453
431
432
437
441
TO LOAD-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.13

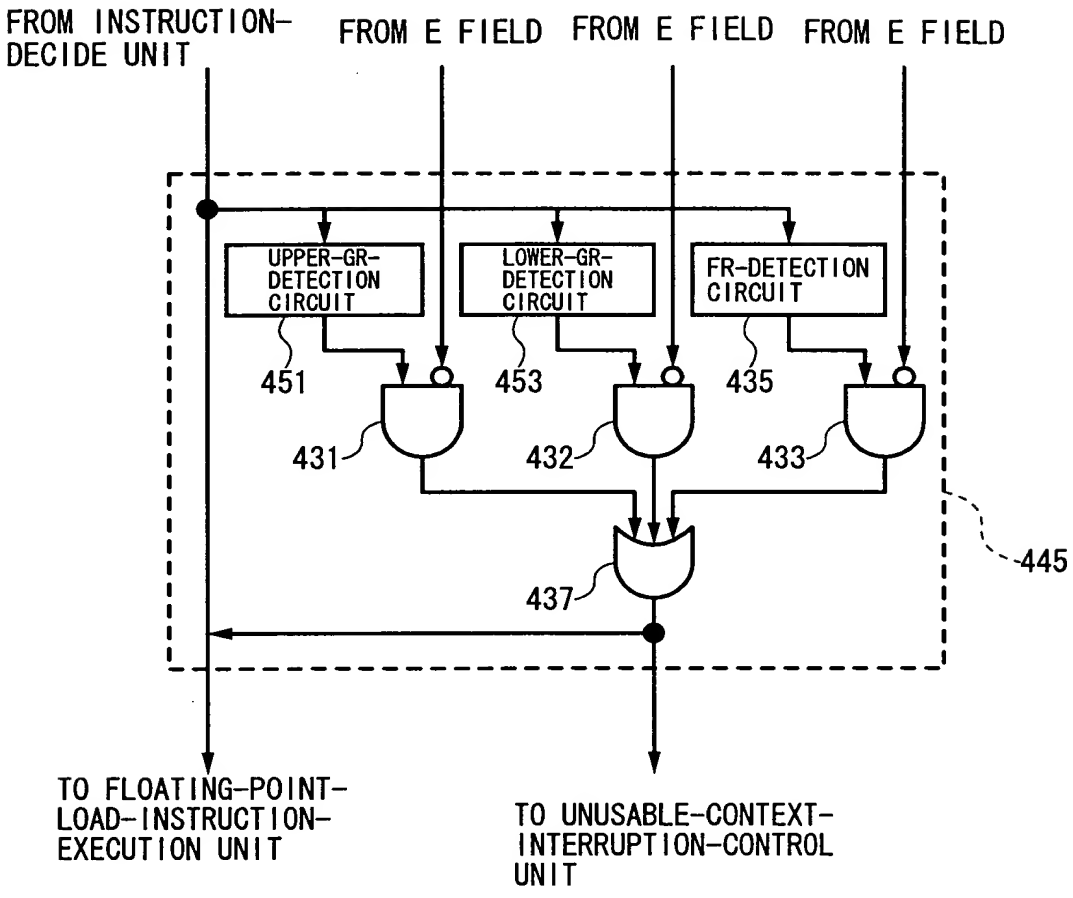

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FROM E FIELD
FROM E FIELD
UPPER-GR-DETECTION CIRCUIT
LOWER-GR-DETECTION CIRCUIT
FR-DETECTION CIRCUIT
451
453
435
431
432
433
437
445
TO FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.14

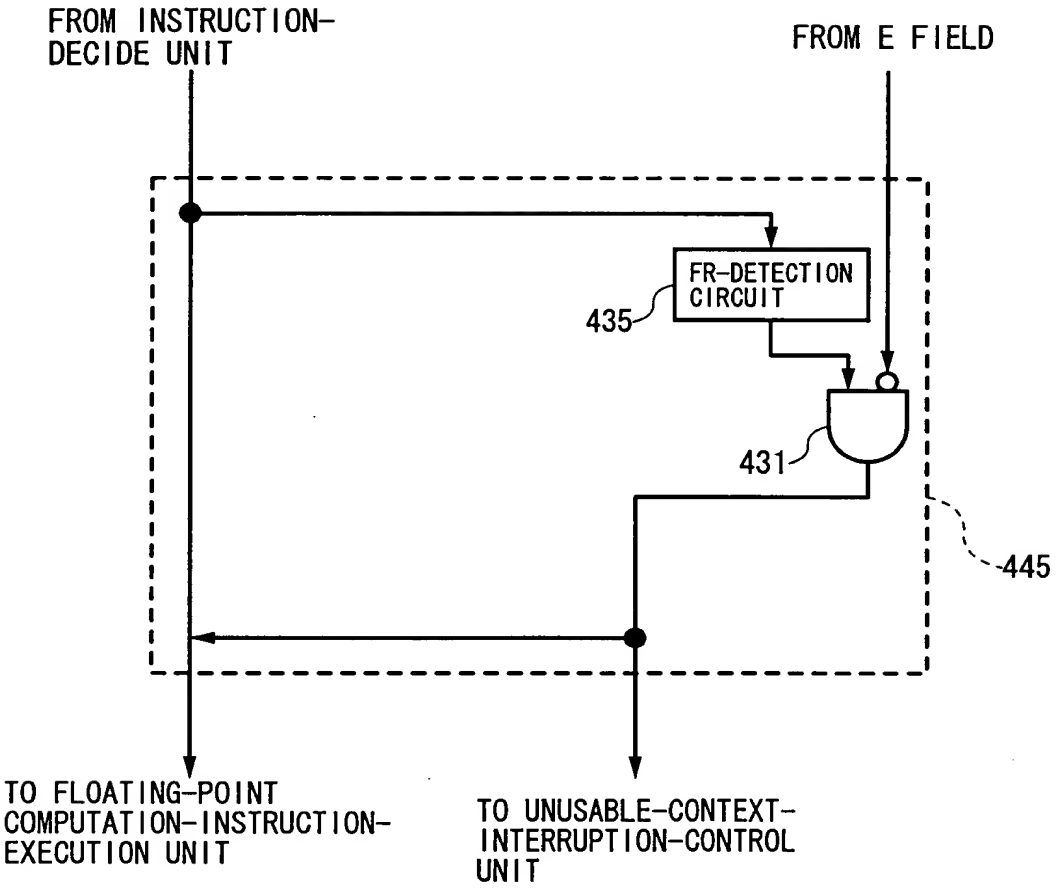

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FR-DETECTION CIRCUIT
435
431
445
TO FLOATING-POINT COMPUTATION-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.15

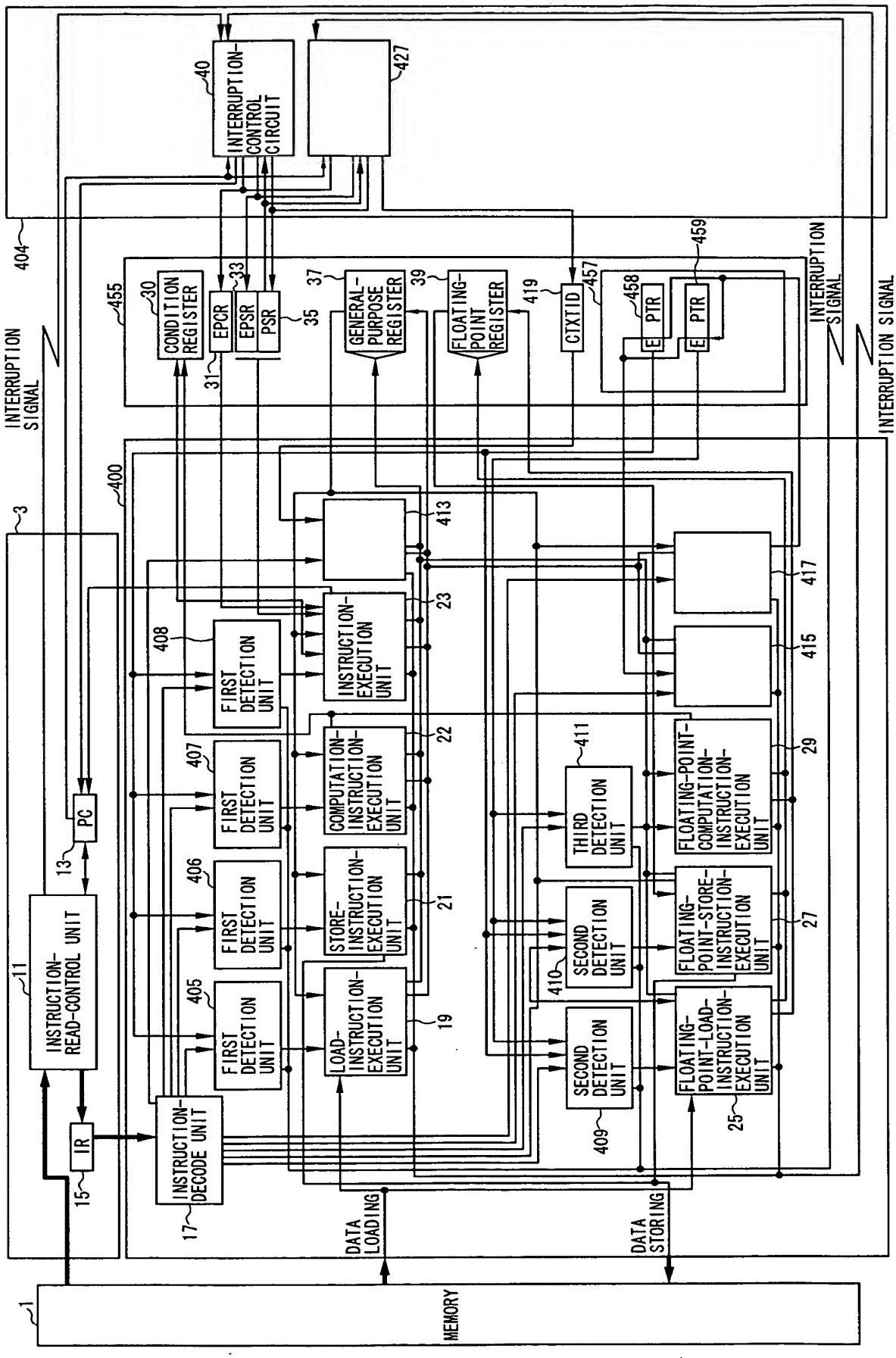

MEMORY
DATA LOADING
DATA STORING
INSTRUCTION-READ-CONTROL UNIT
INSTRUCTION-DECODE UNIT
PC
IR
LOAD-INSTRUCTION-EXECUTION UNIT
STORE-INSTRUCTION-EXECUTION UNIT
COMPUTATION-INSTRUCTION-EXECUTION UNIT
INSTRUCTION-EXECUTION UNIT
FIRST DETECTION UNIT
SECOND DETECTION UNIT
THIRD DETECTION UNIT
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
INTERRUPTION-CONTROL CIRCUIT
INTERRUPTION SIGNAL
CONDITION REGISTER
EPCR
EPSR
PSR
GENERAL-PURPOSE REGISTER
FLOATING-POINT REGISTER
CTXTID
PTR
E
1
3
11
13
15
17
19
21
22
23
25
27
29
30
31
33
35
37
39
40
400
404
405
406
407
408
409
410
411
413
415
417
419
427
455
457
458
459

FIG.16

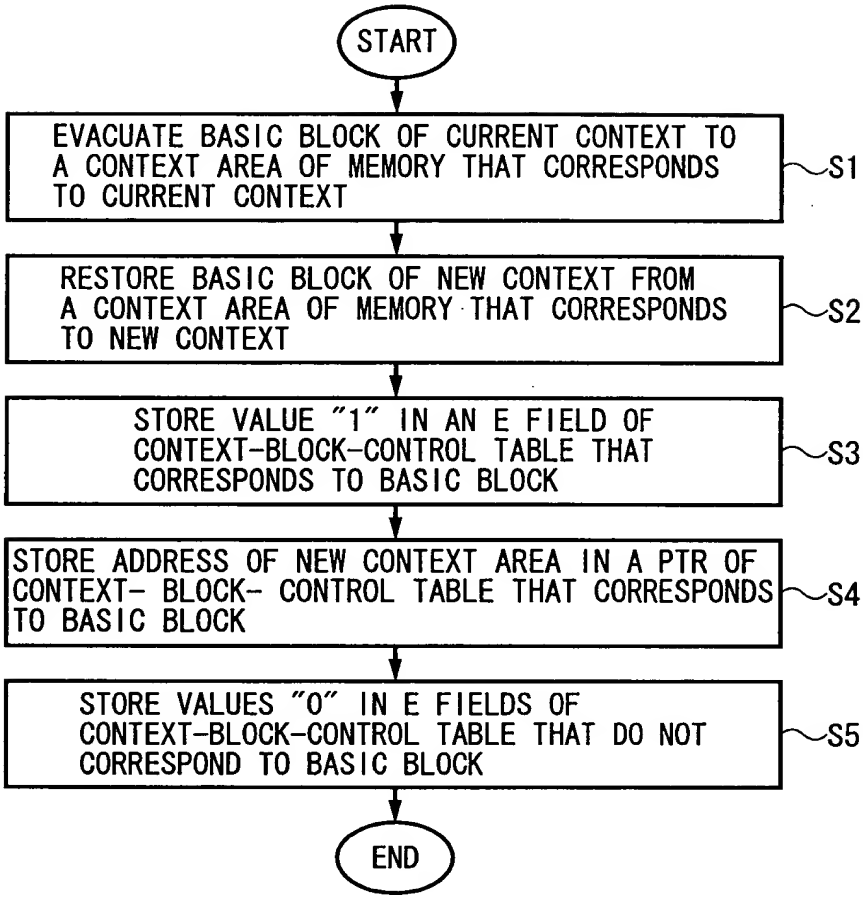

START
EVACUATE BASIC BLOCK OF CURRENT CONTEXT TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT
S1
RESTORE BASIC BLOCK OF NEW CONTEXT FROM A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO NEW CONTEXT
S2
STORE VALUE "1" IN AN E FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO BASIC BLOCK
S3
STORE ADDRESS OF NEW CONTEXT AREA IN A PTR OF CONTEXT- BLOCK- CONTROL TABLE THAT CORRESPONDS TO BASIC BLOCK
S4
STORE VALUES "0" IN E FIELDS OF CONTEXT-BLOCK-CONTROL TABLE THAT DO NOT CORRESPOND TO BASIC BLOCK
S5
END

FIG.17

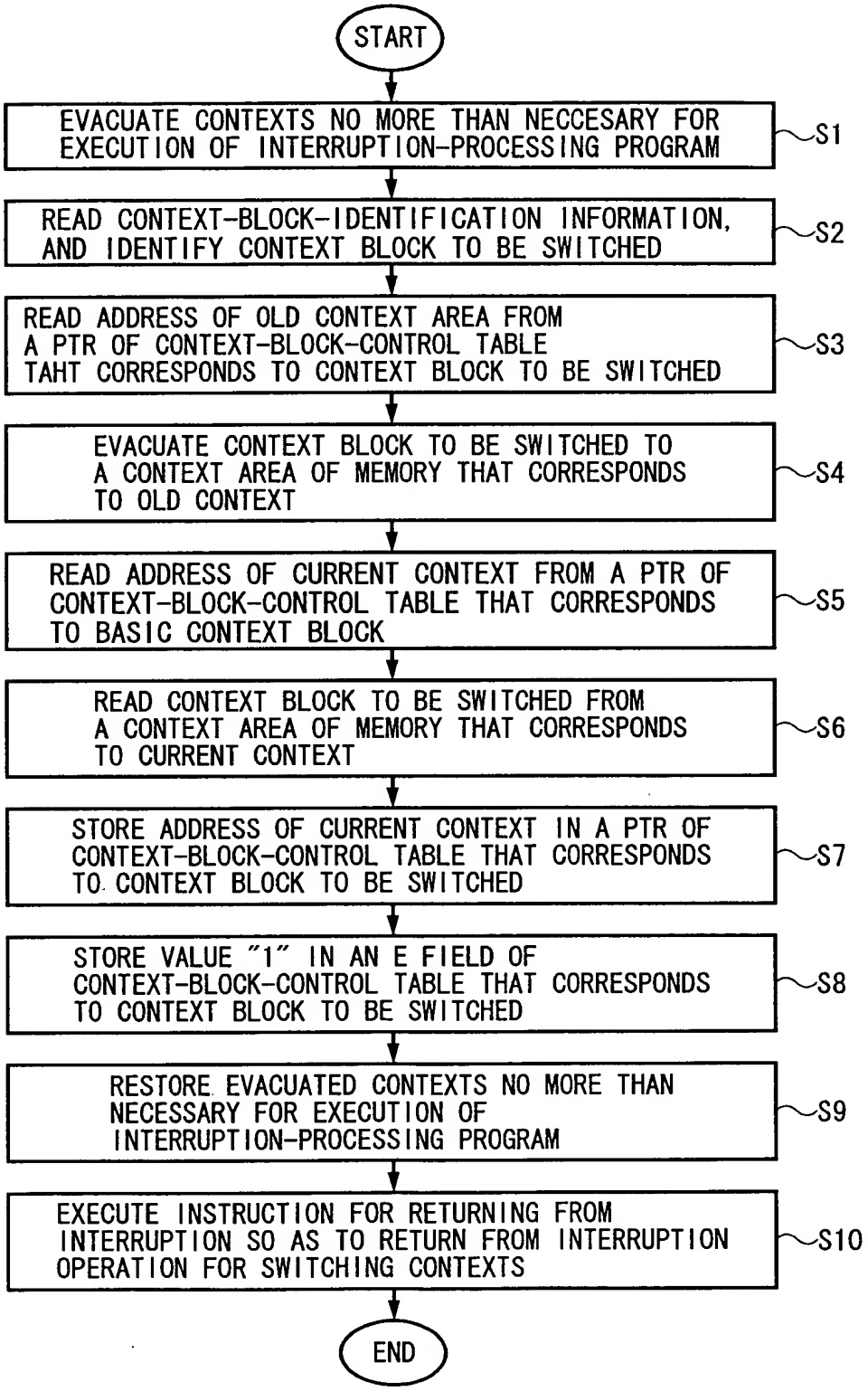

START
EVACUATE CONTEXTS NO MORE THAN NECCESARY FOR EXECUTION OF INTERRUPTION-PROCESSING PROGRAM
S1
READ CONTEXT-BLOCK-IDENTIFICATION INFORMATION, AND IDENTIFY CONTEXT BLOCK TO BE SWITCHED
S2
READ ADDRESS OF OLD CONTEXT AREA FROM A PTR OF CONTEXT-BLOCK-CONTROL TABLE TAHT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S3
EVACUATE CONTEXT BLOCK TO BE SWITCHED TO A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO OLD CONTEXT
S4
READ ADDRESS OF CURRENT CONTEXT FROM A PTR OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO BASIC CONTEXT BLOCK
S5
READ CONTEXT BLOCK TO BE SWITCHED FROM A CONTEXT AREA OF MEMORY THAT CORRESPONDS TO CURRENT CONTEXT
S6
STORE ADDRESS OF CURRENT CONTEXT IN A PTR OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S7
STORE VALUE "1" IN AN E FIELD OF CONTEXT-BLOCK-CONTROL TABLE THAT CORRESPONDS TO CONTEXT BLOCK TO BE SWITCHED
S8
RESTORE EVACUATED CONTEXTS NO MORE THAN NECESSARY FOR EXECUTION OF INTERRUPTION-PROCESSING PROGRAM
S9
EXECUTE INSTRUCTION FOR RETURNING FROM INTERRUPTION SO AS TO RETURN FROM INTERRUPTION OPERATION FOR SWITCHING CONTEXTS
S10
END

FIG.18

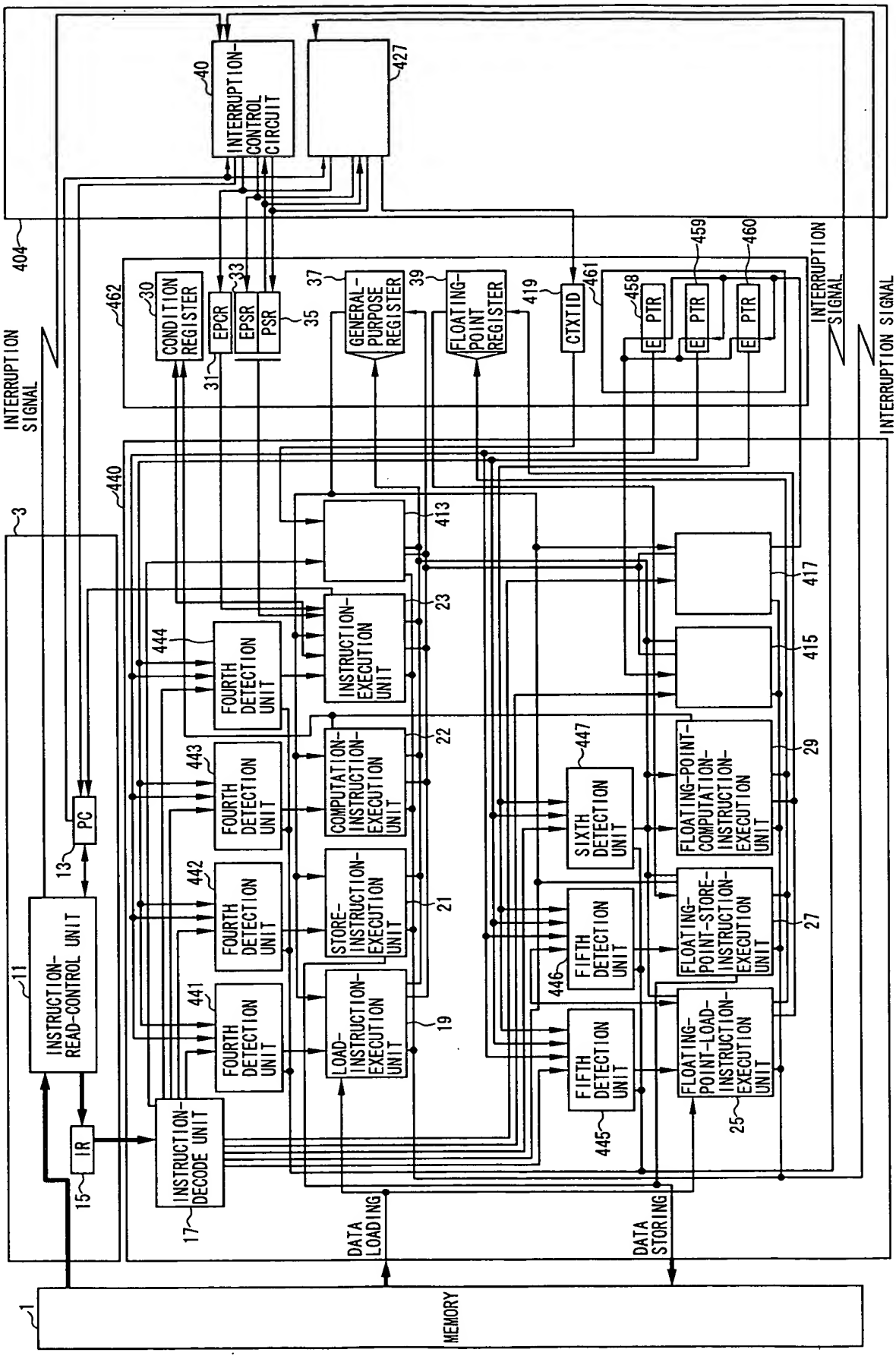

MEMORY
DATA LOADING
DATA STORING
INTERRUPTION SIGNAL
INTERRUPTION SIGNAL
INSTRUCTION-READ-CONTROL UNIT
PC
IR
INSTRUCTION-DECODE UNIT
LOAD-INSTRUCTION-EXECUTION UNIT
STORE-INSTRUCTION-EXECUTION UNIT
COMPUTATION-INSTRUCTION-EXECUTION UNIT
INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
FOURTH DETECTION UNIT
FIFTH DETECTION UNIT
SIXTH DETECTION UNIT
INTERRUPTION-CONTROL CIRCUIT
CONDITION REGISTER
EPCR
EPSR
PSR
GENERAL-PURPOSE REGISTER
FLOATING-POINT REGISTER
CTXTID
PTR
PTR
PTR
INTERRUPTION SIGNAL
1
3
11
13
15
17
19
21
22
23
25
27
29
30
31
33
35
37
39
40
404
413
415
417
419
427
440
441
442
443
444
445
446
447
458
459
460
461
462

FIG.19

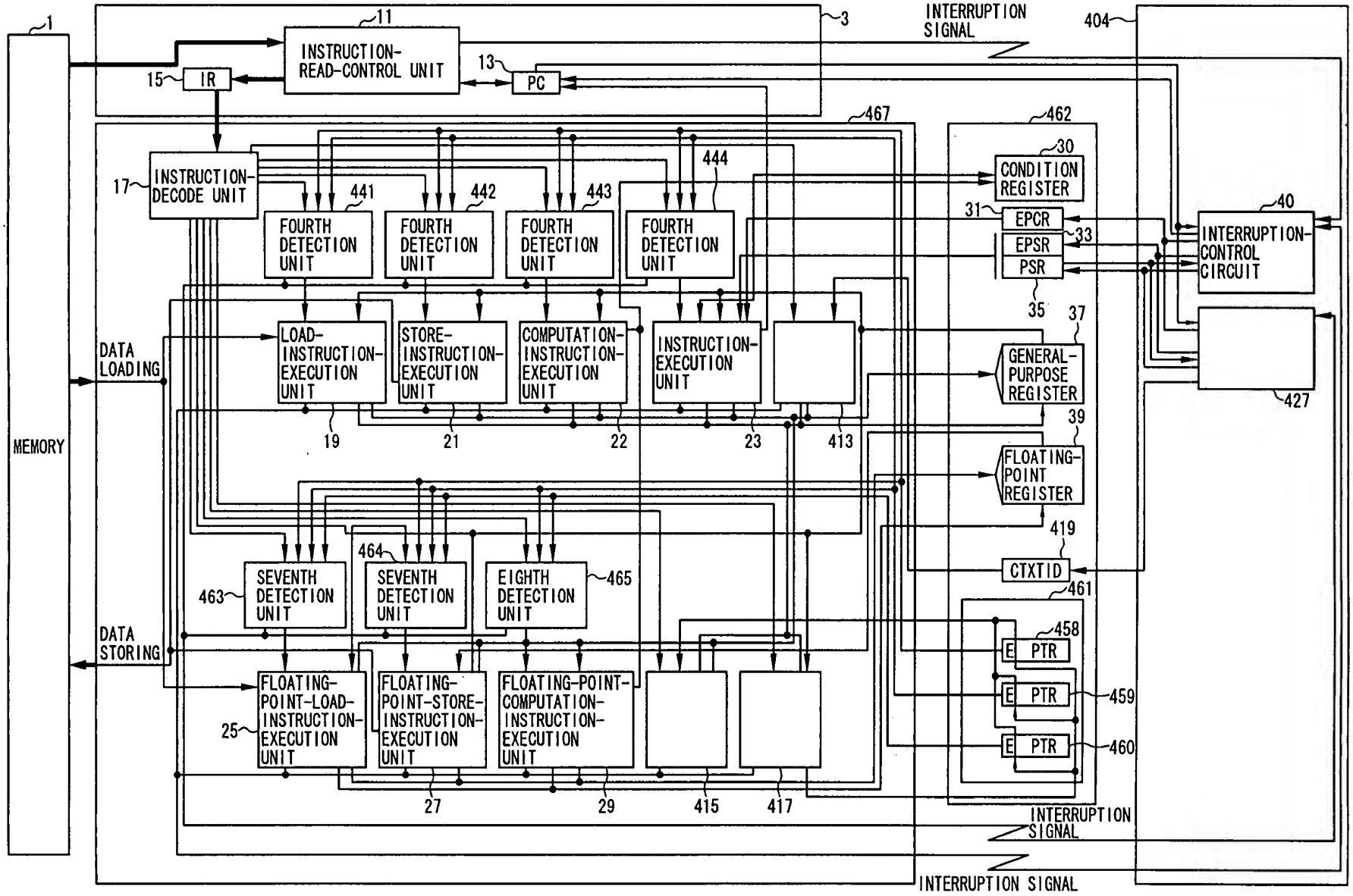

1
MEMORY
3
11
INSTRUCTION-READ-CONTROL UNIT
13
PC
15
IR
17
INSTRUCTION-DECODE UNIT
INTERRUPTION SIGNAL
404
467
462
30
CONDITION REGISTER
31
EPCR
33
EPSR
PSR
35
40
INTERRUPTION-CONTROL CIRCUIT
37
GENERAL-PURPOSE REGISTER
427
39
FLOATING-POINT REGISTER
419
CTXTID
461
458
E PTR
459
460
441
442
443
444
FOURTH DETECTION UNIT
LOAD-INSTRUCTION-EXECUTION UNIT
STORE-INSTRUCTION-EXECUTION UNIT
COMPUTATION-INSTRUCTION-EXECUTION UNIT
INSTRUCTION-EXECUTION UNIT
19
21
22
23
413
DATA LOADING
DATA STORING
463
464
465
SEVENTH DETECTION UNIT
EIGHTH DETECTION UNIT
25
FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-STORE-INSTRUCTION-EXECUTION UNIT
FLOATING-POINT-COMPUTATION-INSTRUCTION-EXECUTION UNIT
27
29
415
417
INTERRUPTION SIGNAL
INTERRUPTION SIGNAL

FIG.20

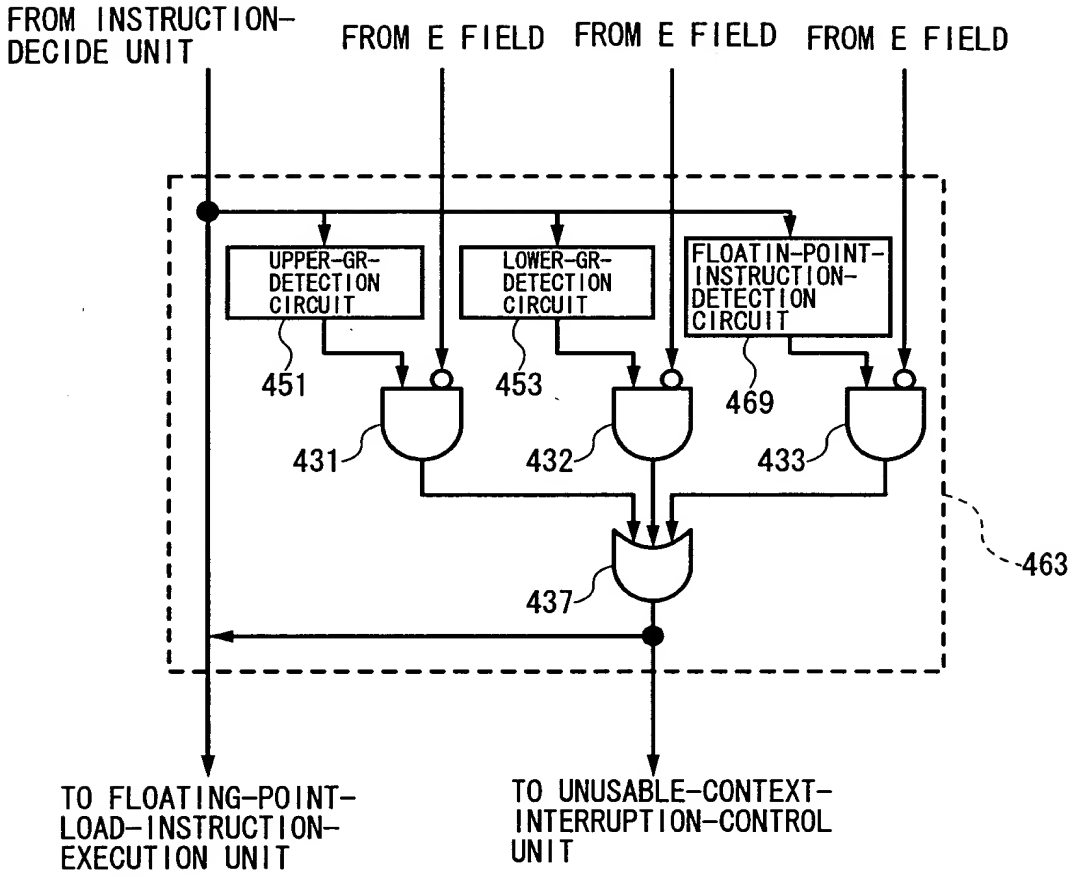

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FROM E FIELD
FROM E FIELD
UPPER-GR-DETECTION CIRCUIT
LOWER-GR-DETECTION CIRCUIT
FLOATIN-POINT-INSTRUCTION-DETECTION CIRCUIT
451
453
469
431
432
433
437
463
TO FLOATING-POINT-LOAD-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.21

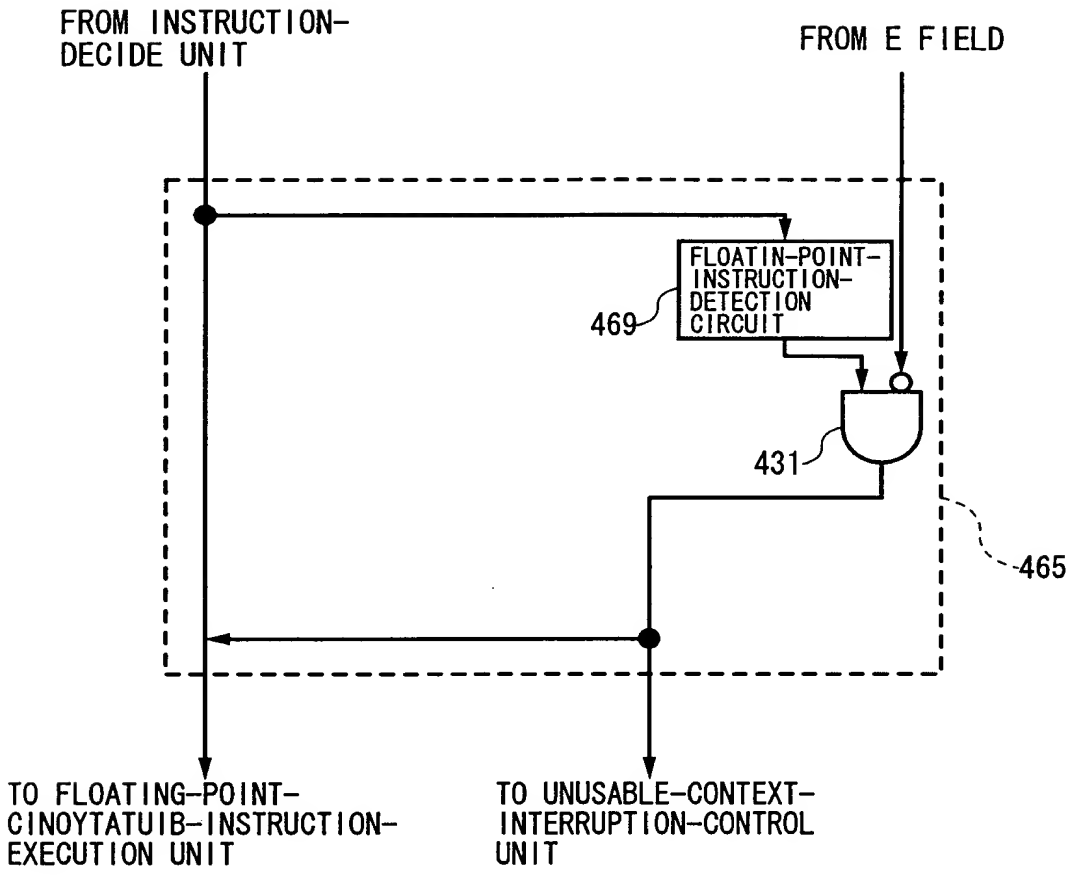

FROM INSTRUCTION-DECIDE UNIT
FROM E FIELD
FLOATIN-POINT-INSTRUCTION-DETECTION CIRCUIT
469
431
465
TO FLOATING-POINT-CINOYTATUIB-INSTRUCTION-EXECUTION UNIT
TO UNUSABLE-CONTEXT-INTERRUPTION-CONTROL UNIT

FIG.22

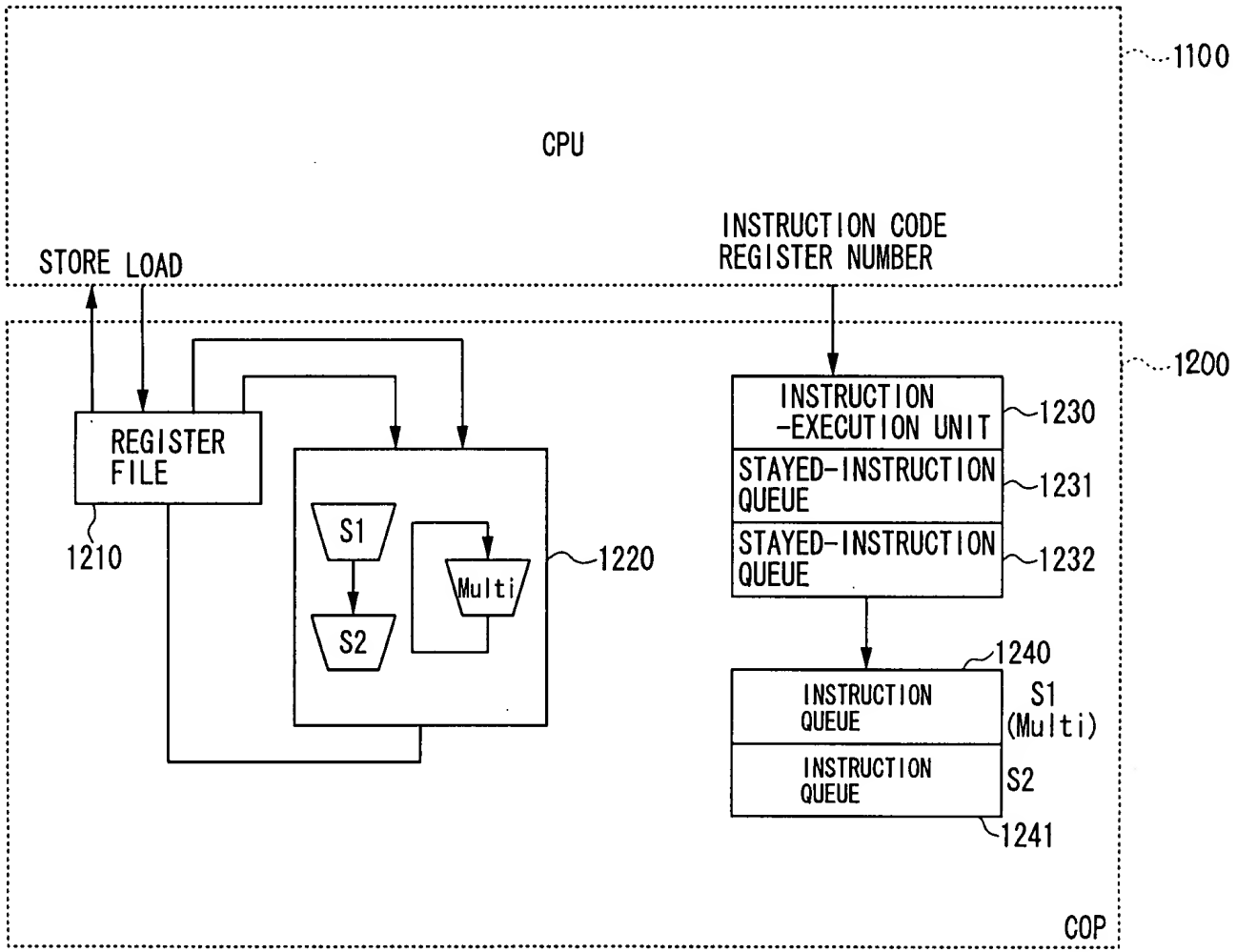

1100
CPU
INSTRUCTION CODE
REGISTER NUMBER
STORE LOAD
1200
REGISTER
FILE
1210
S1
S2
Multi
1220
INSTRUCTION
-EXECUTION UNIT
1230
STAYED-INSTRUCTION
QUEUE
1231
STAYED-INSTRUCTION
QUEUE
1232
1240
INSTRUCTION
QUEUE
S1
(Multi)
INSTRUCTION
QUEUE
S2
1241
COP

FIG.23

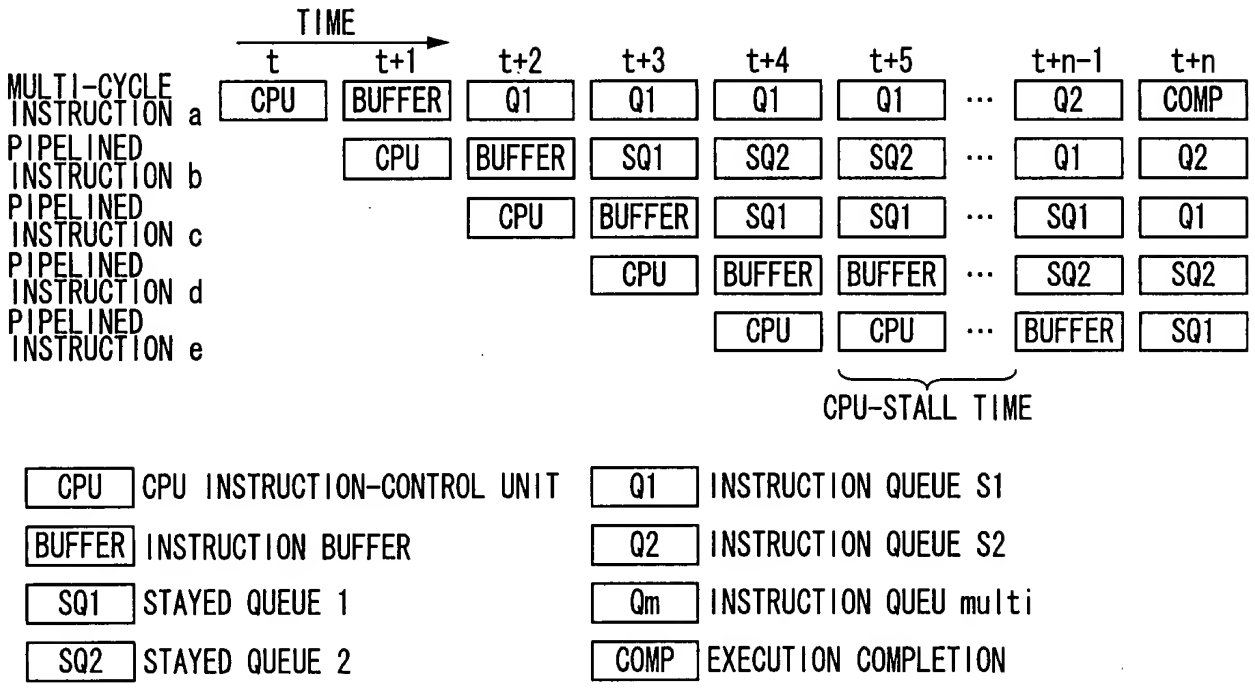

TIME
t
t+1
t+2
t+3
t+4
t+5
t+n-1
t+n
MULTI-CYCLE INSTRUCTION a
PIPELINED INSTRUCTION b
PIPELINED INSTRUCTION c
PIPELINED INSTRUCTION d
PIPELINED INSTRUCTION e
CPU
BUFFER
Q1
SQ1
SQ2
Q2
COMP
CPU-STALL TIME
CPU CPU INSTRUCTION-CONTROL UNIT
BUFFER INSTRUCTION BUFFER
SQ1 STAYED QUEUE 1
SQ2 STAYED QUEUE 2
Q1 INSTRUCTION QUEUE S1
Q2 INSTRUCTION QUEUE S2
Qm INSTRUCTION QUEU multi
COMP EXECUTION COMPLETION

FIG.24

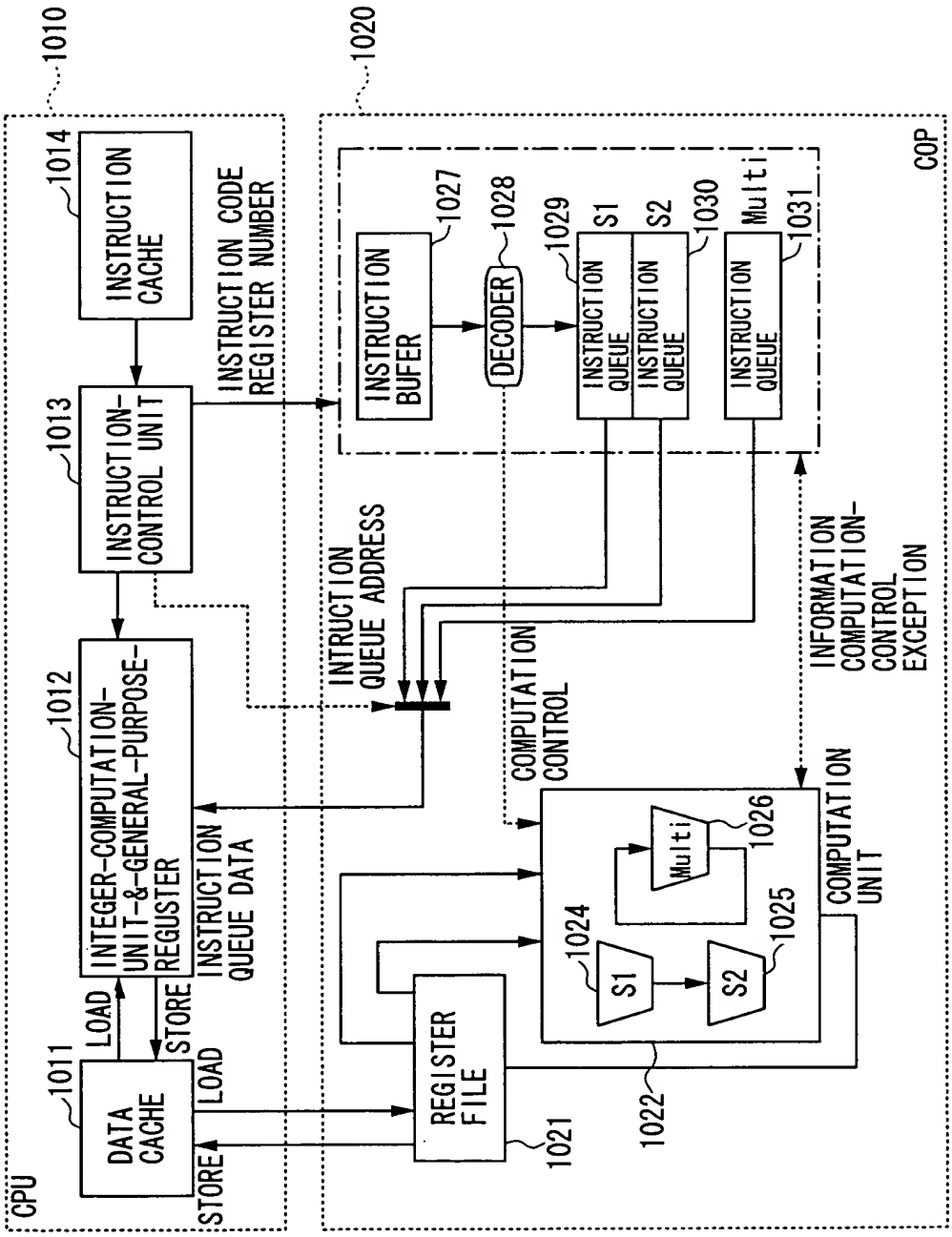

1010
1020
1014
INSTRUCTION CACHE
INSTRUCTION CODE REGISTER NUMBER
1013
INSTRUCTION-CONTROL UNIT
1012
INTEGER-COMPUTATION-UNIT-&-GENERAL-PURPOSE-REGUSTER
INSTRUCTION QUEUE DATA
LOAD
STORE
1011
DATA CACHE
LOAD
STORE
CPU
INTRUCTION QUEUE ADDRESS
INSTRUCTION BUFER
1027
DECODER
1028
INSTRUCTION QUEUE
1029
S1
INSTRUCTION QUEUE
S2
1030
INSTRUCTION QUEUE
Multi
1031
COP
COMPUTATION CONTROL
INFORMATION COMPUTATION-CONTROL EXCEPTION
REGISTER FILE
1021
1022
1024
S1
Multi
1026
S2
1025
COMPUTATION UNIT

FIG.25

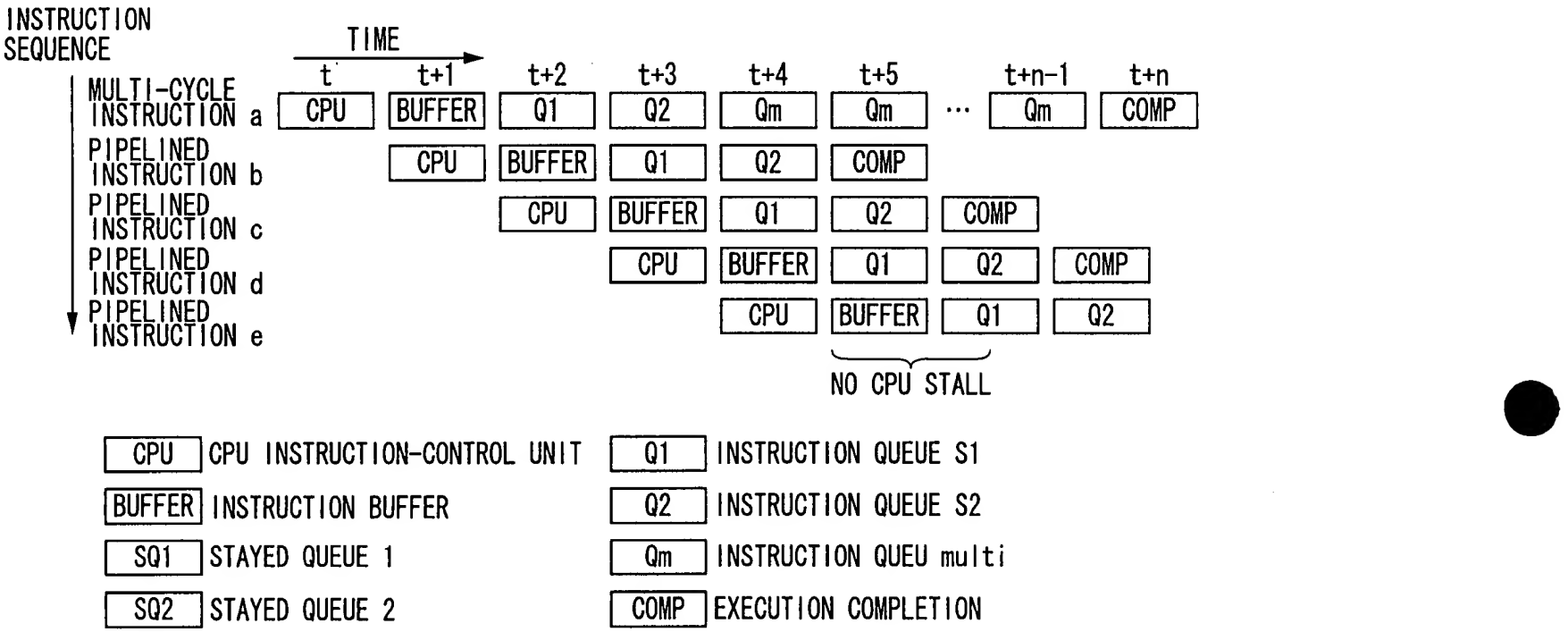
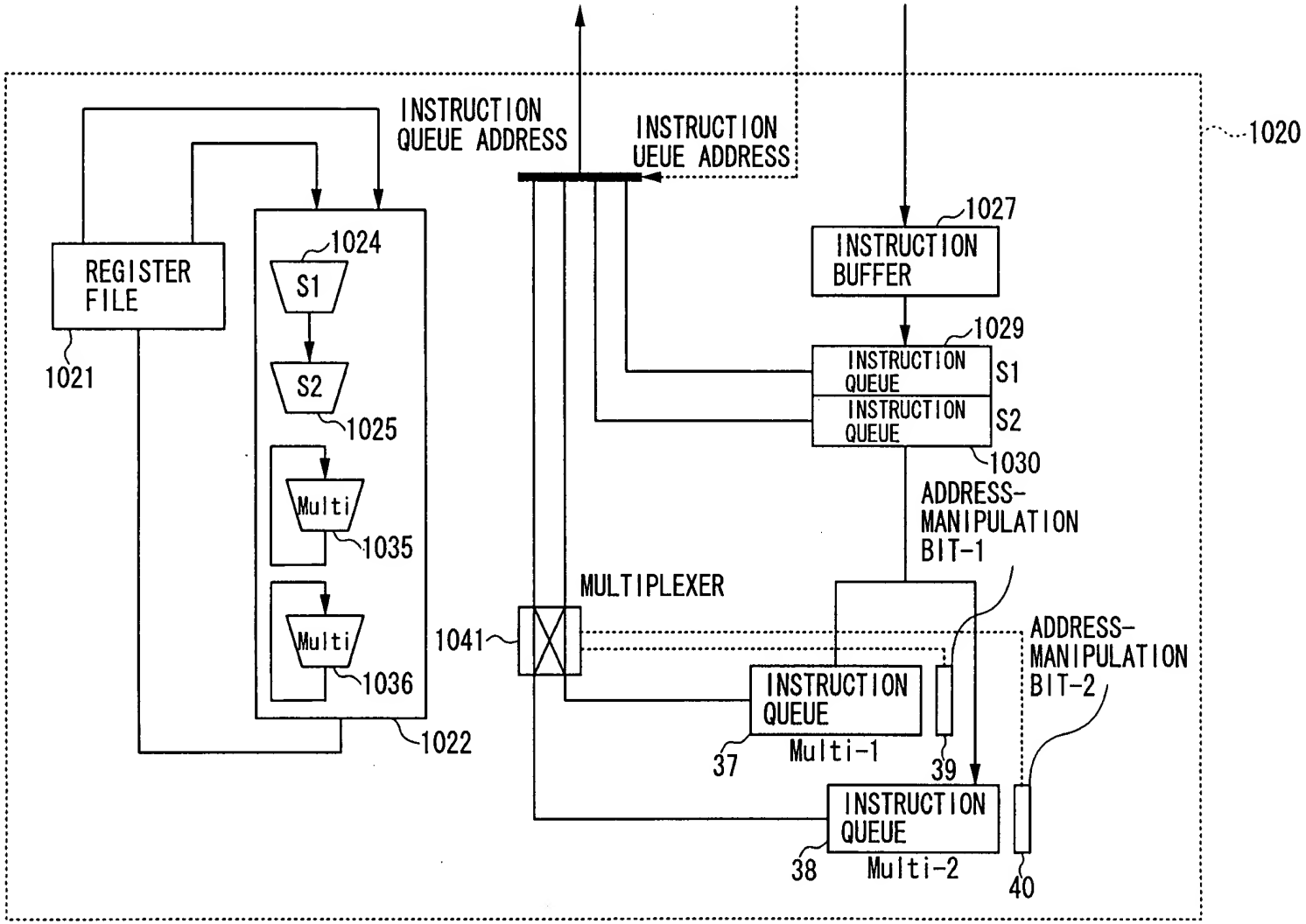

INSTRUCTION SEQUENCE
TIME
t
t+1
t+2
t+3
t+4
t+5
t+n-1
t+n
MULTI-CYCLE INSTRUCTION a
CPU
BUFFER
Q1
Q2
Qm
Qm
Qm
COMP
PIPELINED INSTRUCTION b
CPU
BUFFER
Q1
Q2
COMP
PIPELINED INSTRUCTION c
CPU
BUFFER
Q1
Q2
COMP
PIPELINED INSTRUCTION d
CPU
BUFFER
Q1
Q2
COMP
PIPELINED INSTRUCTION e
CPU
BUFFER
Q1
Q2
NO CPU STALL
CPU CPU INSTRUCTION-CONTROL UNIT
BUFFER INSTRUCTION BUFFER
SQ1 STAYED QUEUE 1
SQ2 STAYED QUEUE 2
Q1 INSTRUCTION QUEUE S1
Q2 INSTRUCTION QUEUE S2
Qm INSTRUCTION QUEU multi
COMP EXECUTION COMPLETION

FIG.26


INSTRUCTION QUEUE ADDRESS
INSTRUCTION UEUE ADDRESS
1020
REGISTER FILE
1021
1024
S1
S2
1025
Multi
1035
Multi
1036
1022
1027
INSTRUCTION BUFFER
1029
INSTRUCTION QUEUE
S1
INSTRUCTION QUEUE
S2
1030
ADDRESS-MANIPULATION BIT-1
MULTIPLEXER
1041
ADDRESS-MANIPULATION BIT-2
INSTRUCTION QUEUE
Multi-1
37
39
INSTRUCTION QUEUE
Multi-2
38
40

TOSHIBA - RESTRICTED

FIG.27

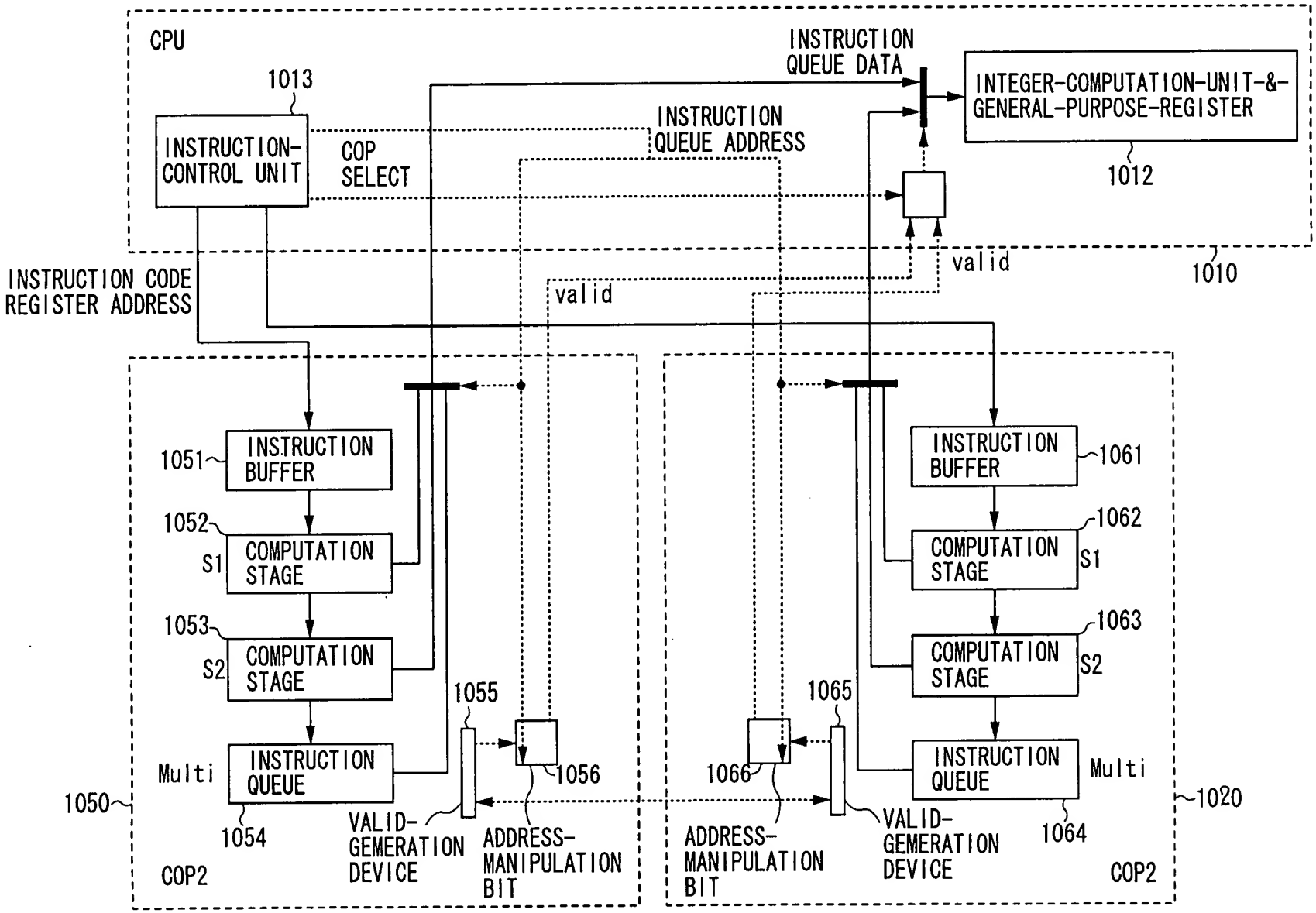


FIG. 28

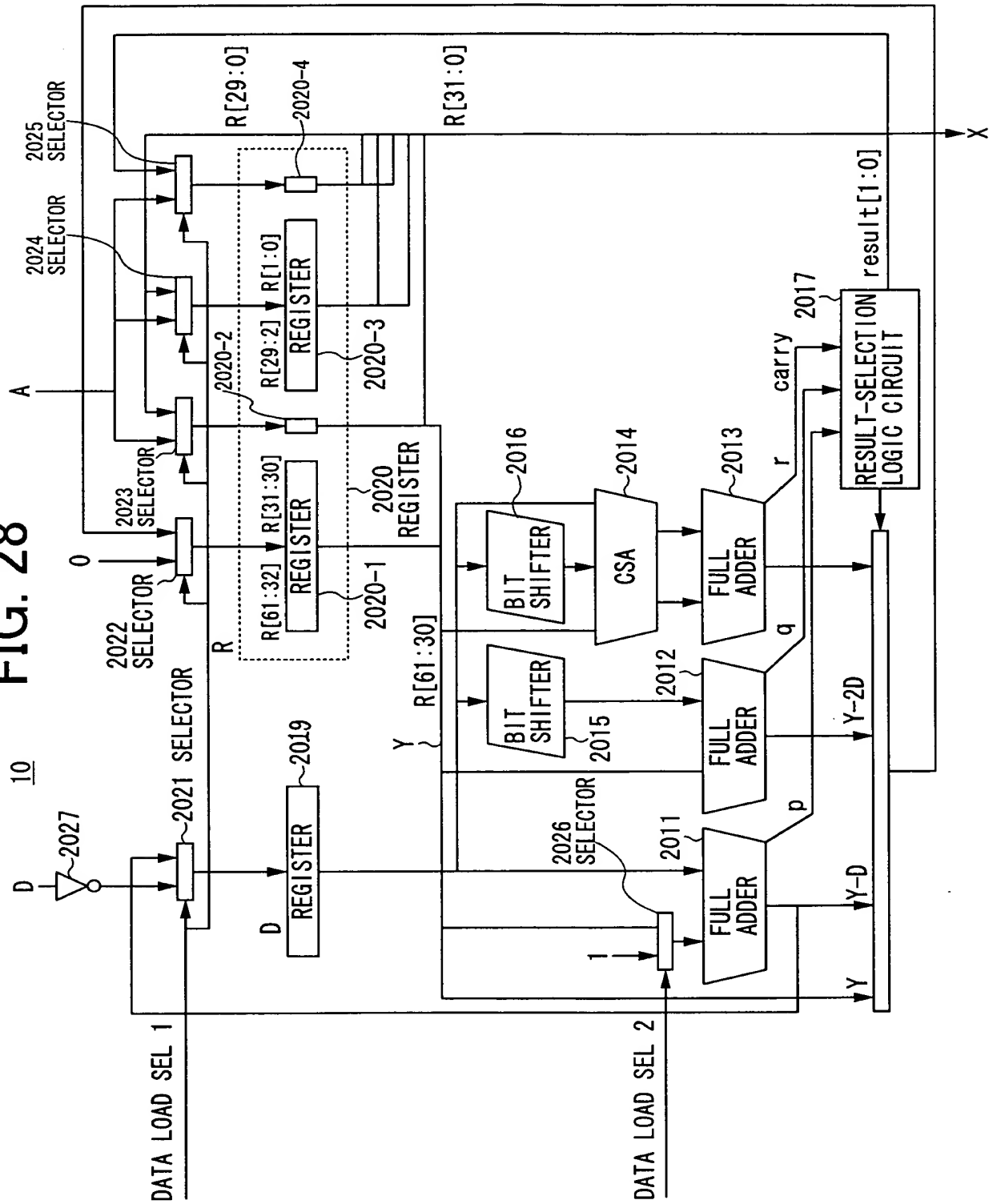
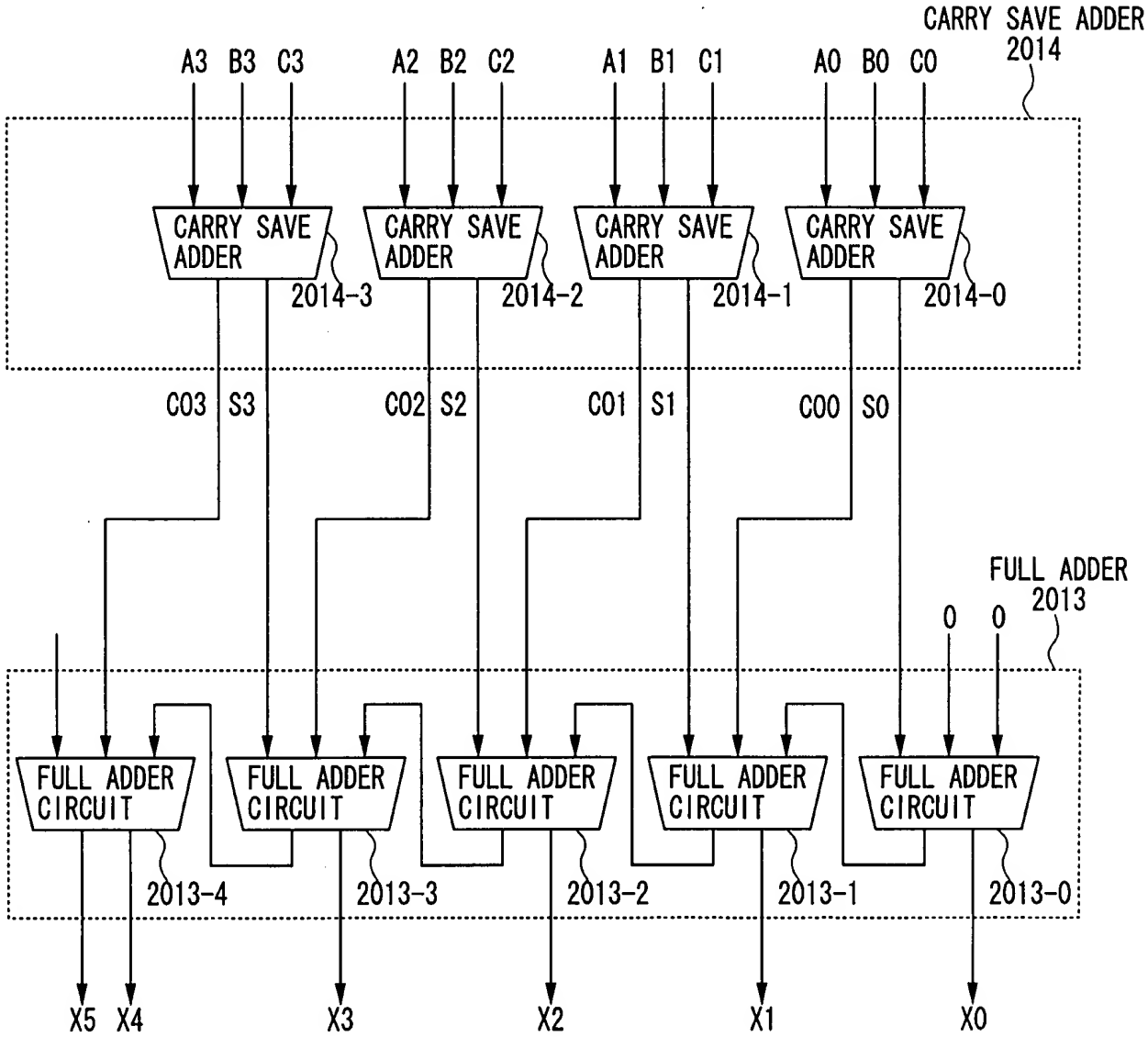

10
DATA LOAD SEL 1
DATA LOAD SEL 2
D
2027
2021 SELECTOR
2019
REGISTER
2022 SELECTOR
2023 SELECTOR
2024 SELECTOR
2025 SELECTOR
A
0
R
2020 REGISTER
2020-1
2020-2
2020-3
2020-4
R[61:32]
R[31:30]
R[29:2]
R[1:0]
R[29:0]
R[31:0]
Y
R[61:30]
BIT SHIFTER
2015
2016
CSA
2014
FULL ADDER
2011
2012
2013
1
2026 SELECTOR
p
q
r
carry
2017
RESULT-SELECTION LOGIC CIRCUIT
result[1:0]
Y-D
Y-2D
X

FIG.29

INPUT p	INPUT q	INPUT r	QUOTIENT (result)	SELECTED REMAINDER
0	0	0	00	Y
1	0	0	01	Y-D
X	1	0	10	Y-2D
X	X	1	11	Y-3D

FIG.30


CARRY SAVE ADDER
2014
A3 B3 C3
A2 B2 C2
A1 B1 C1
A0 B0 C0
CARRY SAVE ADDER
2014-3
CARRY SAVE ADDER
2014-2
CARRY SAVE ADDER
2014-1
CARRY SAVE ADDER
2014-0
C03 S3
C02 S2
C01 S1
C00 S0
FULL ADDER
2013
0 0
FULL ADDER CIRCUIT
2013-4
FULL ADDER CIRCUIT
2013-3
FULL ADDER CIRCUIT
2013-2
FULL ADDER CIRCUIT
2013-1
FULL ADDER CIRCUIT
2013-0
X5 X4
X3
X2
X1
X0

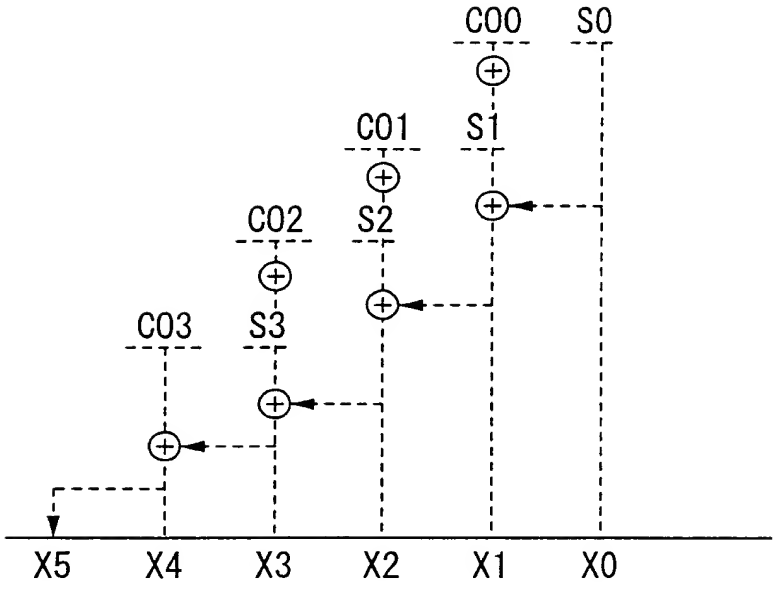



FIG. 31